FOOD TECHNOLOGY

PUBLISHED BY THE INSTITUTE OF FOOD TECHNOLOGISTS

IN THIS ISSUE

Comparisons of the Quality and Stability of Whole Egg Powders Desugared by the Yeast and Enzyme Methods / *343*

Concentration of Strawberry Juice / *350*

Hygroscopic Equilibria of Dry Beans / *353*

The Browning of Canned Bread Crumb / *355*

The Tenderization of Peas During Vining / *358*

An Exploration of the Effects of Strong Radio-Frequency Fields on Microorganisms in Aqueous Solutions / *361*

The Influence of Lipids on Self-Dispersion and on Ease of Dispersion of Milk Powder / *367*

Consumer-Type Appraisal of Whole Egg Powders Stabilized by Glucose Removal (Yeast Fermentation) and by Acidification / *372*

Peanut Butter. VI. The Effect of Roasting on the Palatability of Peanut Butter / *377*

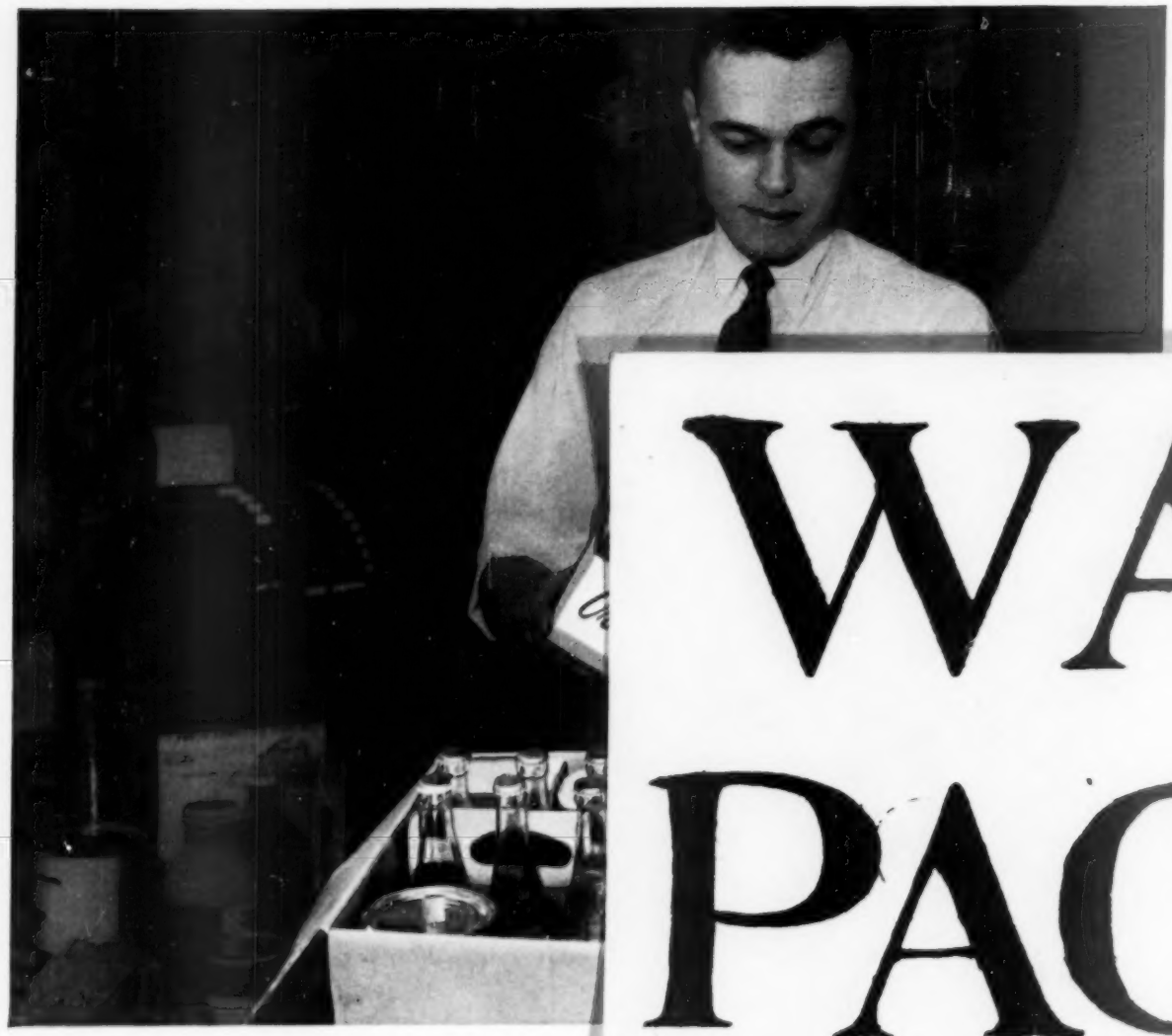
Peanut Butter. VIII. Effects of Processing and Storage on Vitamin A Incorporated in Peanut Butter / *381*

Notes and Letters / *385*

Affairs of the Institute / *2*

Pages 343-386

August, 1954 Volume 8, Number 8



WA
PAG

there's a powerful sales plus in

VITAMIN FORTIFI

● Give your soft drinks health appeal . . . an outstanding sales plus for any food product today. And the cost? *Just a fraction of a cent per bottle.* That's all it takes to add Pfizer vitamins in ample quantities.

Look to Pfizer for the help you need to capture your share of the ever-growing market of adults and children who are vitamin conscious in their choice of beverages. With Pfizer you have the benefit of laboratory data and working experience in food and beverage fortification—experience gathered during more than 18 years of prominence in vitamin manufacturing.

For further information on how to fortify your soft drinks, write:

CHAS. PFIZER & CO., INC.
CHEMICAL SALES DIVISION
630 Flushing Ave., Brooklyn 6, N. Y.
Branch Offices: Chicago, Ill.; San Francisco, Calif.; Vernon, Calif.; Atlanta, Ga.

Pioneer and Leading Manufacturer of Vitamins

Pfizer

AVY

GES

ATLAS CERTIFIED COLORS

Industry's standard for 103 years

FIRST PRODUCERS OF CERTIFIED COLORS

KOHNSTAMM & COMPANY Inc.

ESTABLISHED 1851

89 PARK PLACE, NEW YORK 7 • 11-13 E. ILLINOIS ST., CHICAGO 11 • 4735 DISTRICT BLVD., LOS ANGELES 11

BRANCHES IN OTHER PRINCIPAL CITIES OF THE U.S.A. AND THROUGHOUT THE WORLD

there's a powerful sales plus in

VITAMIN FORTIFIED BEVERAGES

● Give your soft drinks health appeal . . . an outstanding sales plus for any food product today. And the cost? *Just a fraction of a cent per bottle.* That's all it takes to add Pfizer vitamins in ample quantities.

Look to Pfizer for the help you need to capture your share of the ever-growing market of adults and children who are vitamin conscious in their choice of beverages. With Pfizer you have the benefit of laboratory data and working experience in food and beverage fortification—experience gathered during more than 18 years of prominence in vitamin manufacturing.

For further information on how to fortify your soft drinks, write:

CHAS. PFIZER & CO., INC.
CHEMICAL SALES DIVISION
630 Flushing Ave., Brooklyn 6, N. Y.
Branch Offices: Chicago, Ill.; San Francisco, Calif.; Vernon, Calif.; Atlanta, Ga.

Pioneer and Leading Manufacturer of Vitamins

Pfizer

ATLAS CERTIFIED COLORS

Industry's standard for 103 years

FIRST PRODUCERS OF CERTIFIED COLORS

KOHNSTAMM & COMPANY Inc.

ESTABLISHED 1851

89 PARK PLACE, NEW YORK 7 • 11-13 E. ILLINOIS ST., CHICAGO 11 • 4735 DISTRICT BLVD., LOS ANGELES 11

BRANCHES IN OTHER PRINCIPAL CITIES OF THE U.S.A. AND THROUGHOUT THE WORLD

Affairs of the Institute

IFT President, Philip K. Bates, Installed in Office
Masters and Doctors in Food Technology
News of the Regional Sections
Personnel
Books
Future Meetings
Recently Elected Members of IFT
Selected Abstracts
Food Industry Topics

IFT President, Philip K. Bates, Installed in Office

At the Installation Luncheon held in the Los Angeles Biltmore's Renaissance Room, July 1, 1954, the presidential gavel of IFT passed from the hands of the retiring president, Berton S. Clark, to Philip K. Bates, new president of the organization. In conferring the gavel on Dr. Bates, Dr. Clark noted that the membership has elected as their top executive a man of outstanding ability and energy and one who has long been active in Institute affairs. The new president has served on numerous IFT committees—the Executive Committee of the Council, the Financial Committee, the Publications Committee, the National Publicity Committee, and others. A former treasurer of IFT, he has an intimate knowledge of the business aspects of running a professional organization of the magnitude of the Institute.

Past President Clark (left) welcomes present President Bates (right) into office.

In professional life, Dr. Bates is general manager of research of the Carnation Company, Van Nuys, California, and in that capacity administers an investigative program concerned with dairy products. This program includes research sponsored at several institutions on such basic problems as the reaction of milk proteins with metals, flavor development in milk products, etc. and applications research, conducted at the Carnation Company's California laboratories, on the better utilization of dairy products, improved methods of processing, and related projects.

Masters and Doctors in Food Technology—1954

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Name	*Degree*	*Thesis or Dissertation*
Alvi, F. R. Mahmood	M.S.	Essential Fatty Acid Deficiency in the Mouse
Hammerle, Olivia Adele	Ph.D.	Some Effects of High-Energy Cathode Rays on Casein
Harriman, Hubert Colways	M.S.	The Reduction of Granulated Sucrose by Coating
Lang, David A.	Ph.D.	Effects of Ionizing Radiations on Lipids
Liebman, Harmon Lester	M.S.	Bacteriological Study of Precooked Frozen Fish
Loftsson, Loftur	M.S.	Freeze-Concentration and a Continuous Jelly Process
Miller, William Clarke	M.S.	Study of Environmental Factors Modifying Radiation Sensitivity of *Bacillus subtilis* Spores
Pomerantz, Reuben	M.S.	Objective Food Color Evaluation by Rapid Spectrophotometric Technique
Stern, Joseph A.	Ph.D.	Equipment, Methods, and Thermal Resistance Studies of Food Spoilage Bacteria.

UNIVERSITY OF MINNESOTA

Ciagne, Raymond	M.S.	Seasonal Variations in Microbiological and Chemical Properties of Some Creamery Water Supplies
Cunningham, Davis K.	Ph.D.	Comparative Studies of the Chemical and Physical Properties of Some Cereal Proteins
Glass, Robert L.	M.S.	Some Effects of Vitamin B_{12} in the Maternal and Post Natal Nutrition of the Rat
Hill, Robert M.	M.S.	An Investigation of the Titration Curves of Native and Heat Denatured β-lactoglobulin in Relation to an Observed Change in Mobility Which Accompanies Such Denaturation
Rudnick, A. W.	Ph.D.	Effect of Heat During Processing of Nonfat Dry Milk Solids Used for Cottage Cheese Manufacture
Thomas, Alan	Ph.D.	A Study of the Mechanism of Sulfhydryl Action in Milk
Walden, Craig C.	Ph.D.	Purification of Wheat Alpha- and Beta-Amylases

UNIVERSITY OF MISSOURI

Birmingham, Eugene	M.S.	Fatness of Pork as it Relates to Consumer Preference
Hedrick, Harold B.	M.S.	Winter Plane of Nutrition as it Relates to Beef Quality
Zobrisky, Steve E.	M.S.	Significant Relationships in Pork Carcass Evaluation

NORTH CAROLINA STATE COLLEGE

Hankin, Lester	Ph.D.	Growth Stimulation of *Lactobacillus casei* by Factors From Animal Tissue
Kennedy, Harvey E.	Ph.D.	Studies with *Lactobacillus casei* on a Bacterial Growth Stimulant in Corn Steep
Kizer, Donald E.	Ph.D.	The Involvement of Certain Carbon and Nitrogen Metabolites in the Nutrition of *Streptococcus lactis* and *Streptococcus cremoris*

(Continued on page 6)

Magic Crystals

Now End Flavor Fading In Your Processed Foods

With Zest,® 99+% Pure Monosodium Glutamate, Food Processors Make Foods More Flavorful Than Ever!

AMERICA'S LEADING FOOD PROCESSORS USE THESE STALEY PRODUCTS

Staley's 99+% Pure Monosodium Glutamate—pure, free-flowing crystals that intensify natural food flavors.

Corn Syrup—Sweetose Brand-high conversion sweetener for firmer texture, better flavor.

Corn Oil—A vegetable oil of highest quality for cooking and food processing.

Lecithin—An established emulsifier and antioxidant for the Food Industry.

No need to let heat, pressure and other processing conditions rob food of taste appeal. Zest magnifies the natural flavors without adding any flavor, color or aroma of its own. Whether your products are frozen, dehydrated or canned, Zest brings out all their natural goodness—puts them first on the consumer's shopping list.

A. E. STALEY MFG. CO., *Decatur, Ill.*

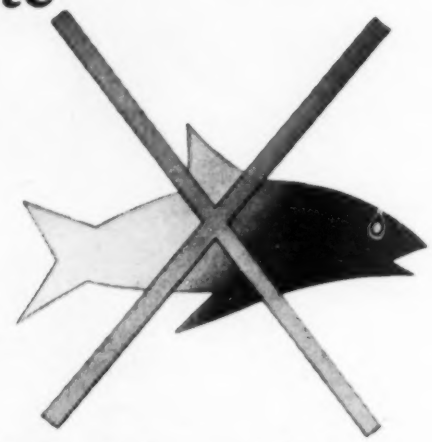
Zest — Staley's

Industries Served by Staley Products

BAKING • CONFECTIONERY • ICE CREAM • FOOD PROCESSING

For an Outstanding Difference in Flavor and Taste

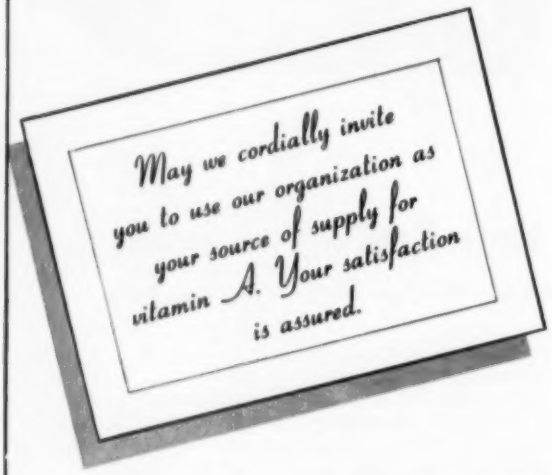
—no fishiness!



USE ROCHE SYNTHETIC VITAMIN A

Economically made from citral which in turn is derived from lemongrass oil, a product of natural vegetable origin.

No longer any objectionable fishy odor, flavor or aftertaste—once you use ROCHE vitamin A, now the world's most widely used synthetic vitamin A for foods and pharmaceuticals. A remarkable achievement made possible by the successful synthesis in ROCHE laboratories in 1947.



- ⊙ PRODUCTION BY THE TONS
- ⊙ FREEDOM FROM WIDE PRICE CHANGES
- ⊙ HIGHEST QUALITY–STRICT CONTROL
- ⊙ UNVARYING STANDARDS
- ⊙ BLENDED TO YOUR SPECIFICATIONS
- ⊙ PROMPT AND COURTEOUS SERVICE
- ⊙ TECHNICAL ASSISTANCE

for food fortification

ROCHE VITAMIN A ACETATE AND PALMITATE

VITAMIN DIVISION • HOFFMANN-LA ROCHE INC.
NUTLEY 10, N. J.

In Canada: Hoffmann-La Roche Ltd., Montreal, Quebec

FOOD TECHNOLOGY

Published Monthly by the Institute of Food Technologists

Editor
MARTIN S. PETERSON
Editorial Office: 11606 South Bell Avenue, Chicago 43, Illinois

Consulting Editor Z. I. KERTESZ
Editor Emeritus C. OLIN BALL

Associate Editors

C. D. ADKINS
JOHN C. AYRES
ROBERT E. BUCK
HAROLD A. CAMPBELL
GEORGE A. CRAPPLE
WILLIAM B. ESSELEN, JR.
ROBERT E. FEENEY
DEAN FOSTER
SAMUEL A. GOLDBLITH
HELEN L. HANSON
WILLIAM R. JOHNSTON
C. HAMILTON KENNEY
AMIHUD KRAMER
HOWARD D. LIGHTBODY
WALTER A. MACLINN
R. E. MORSE
HUGH L. A. TARR
J. G. WOODROOF

ADMINISTRATIVE DATA AND DIRECTORY

Office of the Editor
11606 South Bell Avenue, Chicago 43

Address to this office all manuscripts, proofs, letters pertaining thereto, etc. Prospective contributors are invited to send for the pamphlet *Information and Suggestions to Authors* which contains style instructions.

Responsibility for statements appearing in FOOD TECHNOLOGY rests on the author thereof; points of view expressed in the columns of the journal do not necessarily have the indorsement of the Institute of Food Technologists. Mention of commercial products in the technical pages of this Journal is not to be construed as a recommendation of such products over others in the same category.

Business Manager
CHARLES S. LAWRENCE
176 West Adams St., Chicago 3, Illinois

Address to the business office all requests for subscriptions, changes of address, and information on advertising. Claims for copies lost in the mails must be received 30 days after issue (90 days, foreign). Changes of address must be received at least two weeks before date of issue.

Subscription Rates: For members the cost of subscription is included in the annual dues. Nonmembers: domestic, $8.50 per year; foreign, $10.00 per year. Single and back copies: domestic, $1.00; foreign, $1.25.

Advertising Representatives: *Eastern:* Duncan Macpherson, 700 S. Washington Square, Philadelphia 6, Pa. *Midwestern:* Prendergast and Minahan, 168 N. Michigan Avenue, Chicago 1. *West Coast:* Duana Wanamaker, 610 S. Broadway, Los Angeles 14, California.

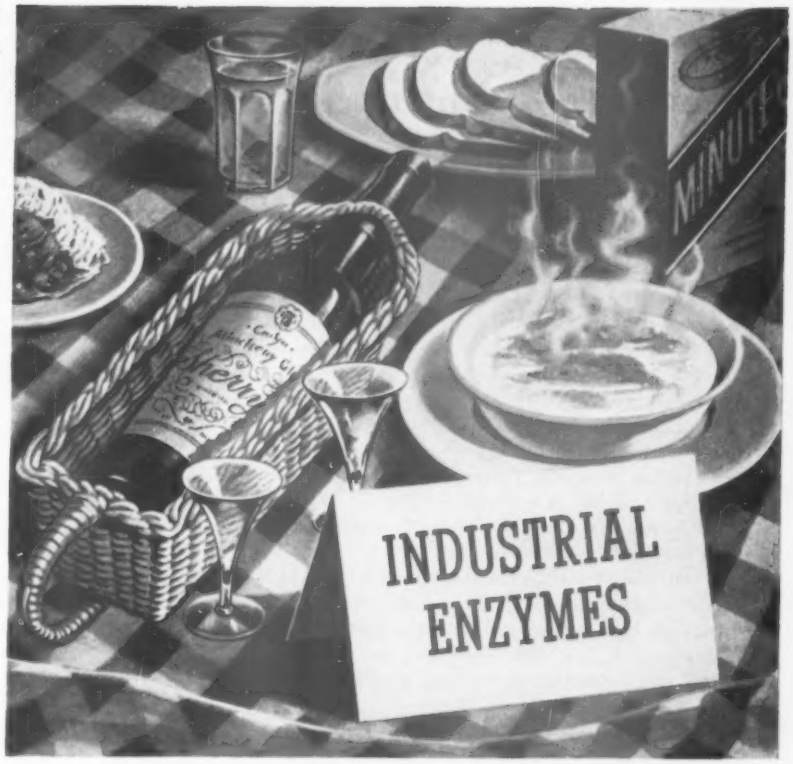
Publication Office
The Garrard Press,
119 West Park Avenue,
Champaign, Illinois

Address to the Publication Office all requests for non-member subscriptions, back volumes, single copies (costs are listed above). Authors desiring reprints should address orders to this office; rates are printed on the order blank. (Requests for a single reprint of a published paper should be addressed to the author.)

FOOD TECHNOLOGY is published by the Institute of Food Technologists and printed by the Garrard Press, Champaign, Illinois, U. S. A.

Copyright, 1954, by the Institute of Food Technologists.

Mailing Permit: Entered as second-class matter, Feb. 25, 1947, at the Post Office at Champaign, Illinois, under the Act of August 24, 1912.



NATURE'S WAY TO FOOD PROCESSING

(with added Sales Appeal as a bonus)

PECTINASE • DIASTASE • PROTEASE • LACTASE • CELLULASE • LIPASE

Nature herself is the greatest food technologist. For that reason, Rohm & Haas industrial enzymes—nature's products—are often the simplest and most efficient processing aids in food production. The use of Rohm & Haas industrial enzymes avoids unwanted by-products, permits catalysis of specific reactions. The enzymes are easy to use—are adaptable to the mild processing conditions in the food industry.

Rohm & Haas enzymes serve a variety of purposes. PECTINOL clarifies apple and other juices, for example. RHOZYME diastatic enzymes aid in the production of pre-cooked breakfast cereals and sweet syrups. Other Rohm & Haas enzymes help you to make smooth textured bread, non-sandy ice cream of high skim milk content, and chill-proof beer.

Decades of experience with enzymes is readily available to you. Why not take advantage of it?

For complete information on Rohm & Haas enzymes, write Dept. SP.

RHOZYME and PECTINOL are trademarks, Reg. U.S. Pat. Off. and in principal foreign countries.

CHEMICALS FOR INDUSTRY

ROHM & HAAS COMPANY

WASHINGTON SQUARE, PHILADELPHIA 5, PA.

Representatives in principal foreign countries

Monoglycerides?
You take your choice

Fellow in our Research Laboratories keeps trying to improve the whipping properties of evaporated milk, sweetened condensed milk, homogenized milk, light cream, medium cream, and reconstituted dried cream by adding Myverol® Distilled Monoglycerides to them. His results point up some differences between the various Myverol types we make that will be interesting to those developing food specialties based on milk products.

For instance, *Type 18-85*, which we make from refined cottonseed oil, cuts the whipping time without much effect on overrun (excess of finished volume over starting volume). Contrariwise, *Type 18-00*, from hydrogenated lard, boosts the overrun without affecting the whipping time.

When our man used mixtures of the two types, each contributed its own special properties. That is, he obtained high overrun and short whipping time. Then he tried *Type 18-30* (from edible animal fat) and found that it combined the high overrun and low whipping time in optimum fashion.

If large amounts of these monoglycerides were involved, there'd be nothing remarkable about their difference in behavior, but we are here dealing with 1% levels of addition at most. Apparently DPi's unique molecular distillation method of concentrating the active mono out of the usual mono-di reaction mixtures results in an excellent emulsifier or whipping agent. For this conclusion we have a great deal of other evidence too, from other applications.

Little would please our Research Laboratories more than to share the details of this data with anyone entertaining new ideas about dairy-based dessert toppings. Or a lot of other data about a lot of other possibilities opened up by the various kinds of Myverol Distilled Monoglycerides. ***Distillation Products Industries,*** Rochester 3, N. Y. Sales offices: New York and Chicago • W. M. Gillies and Company, Los Angeles and San Francisco • Charles Albert Smith Limited, Montreal and Toronto.

distillers of monoglycerides made from natural fats and oils

DPi

Also...vitamins A and E ...some 3500 Eastman Organic Chemicals for science and industry

Distillation Products Industries
is a division of **Eastman Kodak Company**

Master and Doctors in Food Technology—1954

(Continued from page 2)

Name	*Degree*	*Thesis or Dissertation*
Lazar, James T. Jr.	Ph.D.	A Method of Measuring the Efficiency of Labor Utilization in Market Milk Plants
OREGON STATE COLLEGE		
Aref, Moustafa	Ph.D.	The Nature of the Flavors of Filbert Nuts *(Corylus aoellana)*
Kitson, John A.	M.S.	Rapid Sugar Extraction Procedures for the Analysis of Fresh and Processed Fruits
Thompson, Wallace H.	M.S.	Objective Methods of Determining Maturity in Sweet Corn for Processing
RUTGERS UNIVERSITY		
Borenstein, Benjamin	Ph.D.	An Analytical Method for Galacturonic Acid in Tomatoes and the Changes in the Galacturonic Acid Content of Tomatoes During Storage
Bressler, Lawrence	M.S.	Color Changes During Storage of Prepackaged Cured Ham Sealed in Cellophane Pliofilm Laminate Containers While Surrounded by Various Pressures of Atmosphere.
Broumand, Hormoz	Ph.D.	The Development of a Spectrophotometric Method for Estimation of the Pigmented Compounds of Meat
Clauss, Warren E.	M.S.	A Study of Subjectively Measurable Quality Characteristics of Meat, Associated with the Study of a Definition of Texture
Rikert, John A.	Ph.D.	Effect of Some Antioxidant, Light, Temperature, and Atmospheric Variations on the Color of Meat
Salant, Abner	Ph.D.	A Study of Methods for the Improvement of the Rate of Heat Penetration in Canned Meat Products
STATE COLLEGE OF WASHINGTON		
Cormack, May N.	M.S.	Rate of Destruction Values for Spores of *Clostridium botulinum* Subjected to Moist Heat
Frank, Hilmer A.	Ph.D.	Effect of Ionic Environments on Resistance to Moist Heat of Spores of *Bacillus thermoacidurans.*
Glen, Wilburn	Ph.D.	Bacteriological and Chemical Studies of Cultured Buttermilk
Kirthisinghe, Buddhadasa P.	M.S.	A Short Starter Activity Test
Spencer, John V.	M.S.	Effect of Holding Conditions on Shelf Life of Fresh Poultry Meat
Titus, Dudley	M.S.	The Effect of Time and Temperature of Contact with Subtilin Prior to Heating on the Thermal Resistance of P.A. 3679
Woltman, Jack	M.S.	Methods of Reconstitution and Subsequent Treatments as They Affect the Flavor of Whole Milk Powder
Ziegler, Frank	M.S.	Effect of Processing Treatments on Shelf Life of Fresh Poultry Meat
UNIVERSITY OF WISCONSIN		
Birdsall, John	M.S.	Effect of Chlorinated Hydrocarbon Insecticides on the Flavor of Vegetables
Bixby, John	Ph.D.	Nutritive Quality of Milk Produced under Favorable Conditions
Chicoye, Etzer	M.S.	Factors Responsible for Hay-like Flavor of Vitamin A in Fortified Low Fat Milk
Federer, Adolph	M.S.	Effect of Processing Treatments on Properties of Evaporated Milk

(Continued on page 8)

Notes from the makers of **Myvax Vitamin A**

The confusing story about **vitamin A** and alcohol

You can go on year after year relying on us for the vitamin A you put in food or pharmaceutical products with never a thought to such matters as the baffling reactions between vitamin A and alcohol. But if you ever do run into the problem, here are some thoughts in the matter. These are of two varieties, *in vivo* and *in vitro*.

First, *in vivo*. The imbibing of alcohol raises the level of vitamin A in the blood plasma, provided there is a normal store of it in the liver to draw from. This works so well that it provides a valuable means of finding out if the body is well fixed for vitamin A without the inconvenience of cutting a little piece out of the liver and testing it directly. All that's needed are a few stiff swigs and a sober hematologist. At least some Wisconsin dairy scientists who confined their studies to calves and goats seem to think so.

The *in vitro* picture is of an entirely different character and may be of more interest to your business. Vitamin A esters in alcohol go bad quickly but in a strange way that has nothing to do with oxidation, the usual killer of vitamin A. Instead, the vitamin A esters first split off all their fatty acid, and then you are left with a mixture of anhydro vitamin A, vitamin A ethyl ether, and some decomposition products, but no real vitamin A. Strangely enough, no such decomposition in alcohol takes place if you start out with free vitamin A instead of the more familiar vitamin A esters. There is a slight impediment here to a clear understanding of this situation by those who are not vitamin chemists. That's the fact that "free vitamin A" is known chemically as "vitamin A alcohol." We hope it won't bother you.

The point we'd like to make is that if you have a formulation idea that requires vitamin A to stand up in the presence of alcohol—including glycerine or glycols, which are also alcohols—then vitamin A alcohol may turn the trick. We'd certainly like to work with you in trying it out, or in helping to solve any vitamin A formulation problem, for that matter. You couldn't come to a better or more willing source of vitamin A experience than the makers of Myvax and Myvapack Vitamin A. ***Distillation Products Industries,*** Rochester 3, N. Y. Sales offices: New York and Chicago • W. M. Gillies and Company, Los Angeles and San Francisco • Charles Albert Smith Limited, Montreal and Toronto.

"Myvax" and "Myvapack" are trade-marks.

leaders in research and production of vitamin A

DPi

Also...vitamin E...distilled monoglycerides ...more than 3500 Eastman Organic Chemicals for science and industry

Distillation Products Industries *is a division of* **Eastman Kodak Company**

Master and Doctors in Food Technology—1954

(Continued from page 6)

Name	*Degree*	*Thesis or Dissertation*
Scharschmidt, Rudolph	M.S.	Sloughing Properties of Potatoes for Canning
Schumann, Robert	M.S.	Study of Factors Affecting Storage Stability of Fresh Cranberries
Stein, Jolyon	Ph.D.	Stability of Pigments in Processed Fruit and Vegetable Products

Regional Section News

MARYLAND SECTION

Thirty members and guests were present at the May meeting of the Maryland Section, which was held in the Terrapin Room of the Dining Hall at the University of Maryland, College Park, Maryland, on Friday, May 14, 1954.

The Section was the guest of the Maryland Student Chapter of the IFT. The meeting started with a conducted tour of the campus and then a short break for dinner. Following dinner, the members and guests were addressed by Mr. Robinson Lappin, Director of Food Services of the University, who spoke on the subject of "Molding the Eating Habits of the Next Generation."

Mr. Lappin's talk was very informative and most entertaining. He paid tribute to the work of food scientists and gave concrete examples of how recent food developments have aided Food Service Men in the preparation and serving of food to large groups of people.

He commented that in his opinion, the college student of today was smarter than his brother or father of yesteryear. In fact, the present-day college student forces the Food Service Man out of the food business and into the public relations business.

In training the eating habits of the student over the four years of college life, he said that the teen-age freshman generally doesn't know what he likes or dislikes. He does know that the institution food is not as good as he receives at home. By the end of the year he still doesn't like the food, but he accepts it.

In the sophomore year he is confused as to his likes and dislikes. In his junior year he begins to like the food and by the time his senior year rolls around, he accepts the food without comment.

The moods of the students, the pressure of extra-curricular activities and the imminence of examinations all have an influence on the eating habits of the students. The college tries to give the student a balanced diet of an average of 3400 to 3500 calories per day.

He spoke briefly on the influence of background music while students are eating, and stated that slow music makes the student eat in a leisurely manner while fast music speeds things up.

NEW YORK SECTION

One of the largest meetings ever held by this Section took place on May 19th at the Brass Rail.

At this annual election, the following new officers were chosen:

President: Fred C. Baselt, *American Can Co.*
Vice President: Walter A. Maclinn, *Rutgers University*
Treasurer: A. Haldane Gee, *Foster D. Snell, Inc.*
Secretary: Eleanor M. Crozier, *United Fruit Co.*
National Counselors for 2 years: S. L. Galvin, *Pepsi-Cola Co.;* A. A. Schaal, *Good Housekeeping Bureau*
Directors for 3 years: J. K. Krum, *National Biscuit Co.;* F. K. Lawler, *Food Engineering*
Directors for 2 years: H. A. Campbell, *General Foods Corp.;* (Vacancy to be filled later)
Directors for 1 year: J. C. Baurenfeind, *Hoffman-La Roche, Inc.;* R. C. Sherwood, *Sterwin Chemicals, Inc.*

The drawing card for this large meeting was a 5-man panel discussion of flavor. Dr. H. M. Barnes, Director of the Organic Laboratory, General Foods Corporation, discussed the flavor problems of the food manufacturer, such as costs, consumer acceptance, the need for quality improvement, flavor stability, and the difficulties of accurately controlling and measuring flavors.

The next speaker was Dr. E. H. Hamann, Chief Chemist, Flavor Research, Fritzsche Bros., Inc. Dr. Hamann's very interesting paper covered the derivation of flavoring materials from natural sources and the various methods of manufacture which are involved. He also covered some of the special problems involved in the proper use and application of these natural flavors.

The third speaker was Dr. Jarysch, Director of the Flavor Division of H. Kohnstamm & Company, Inc. Dr. Jarysch discussed both true and artificial fruit flavors and the recent advancements which have been made in both the preparation and application of such flavors.

Methods of utilizing flavoring materials was the subject covered by the fourth speaker, Dr. A. H. Downey, Director of Research and Technology of Magnus, Mabee & Reynard. One of the most interesting points covered by Dr. Downey was his data on how concentrated certain flavors may be and what small amounts are required to properly flavor very large amounts of finished products.

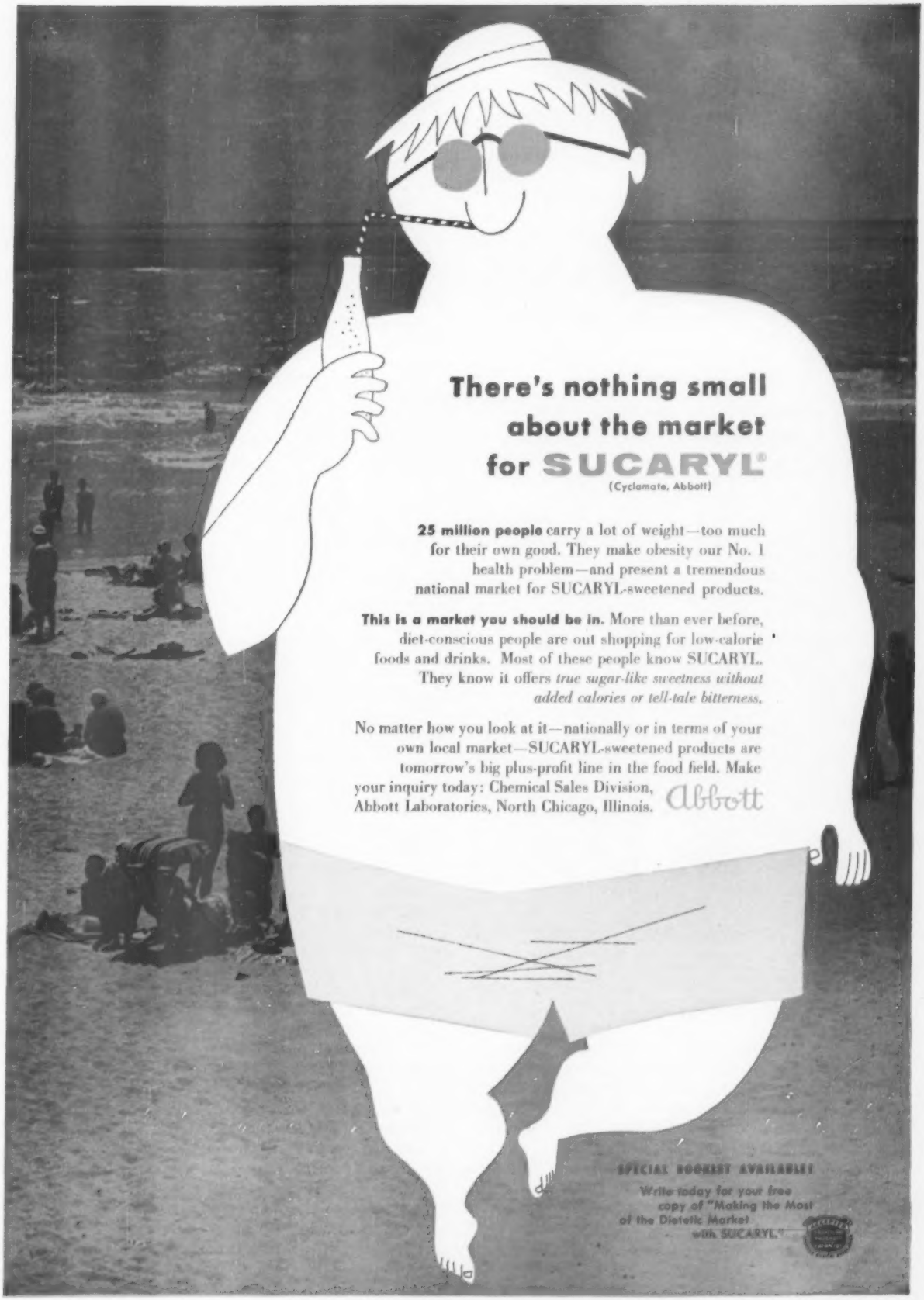
The final speaker was Mr. L. C. Cartwright, of Foster D. Snell, Inc., who spoke on flavor preference factors. Mr. Cartwright's talk made very clear the complicated nature of these preferences and the difficulty in obtaining sound consumer data and properly evaluating it.

OHIO VALLEY SECTION

The following officers, councilor, and executive committee members for the Ohio Valley Section of the Institute of Food Technologists for 1954-1955 have been elected:

Chairman: George F. Garnatz, *The Kroger Company,* Cincinnati, Ohio
Vice Chairman: Fred E. Deatherage, *Dept. of Agricultural Biochemistry,* The Ohio State University, Columbus, Ohio
Secretary-Treasurer: M. Eloise Green, *School of*

(Continued on page 10)


There's nothing small about the market for SUCARYL®
(Cyclamate, Abbott)
25 million people carry a lot of weight—too much for their own good. They make obesity our No. 1 health problem—and present a tremendous national market for SUCARYL-sweetened products.
This is a market you should be in. More than ever before, diet-conscious people are out shopping for low-calorie foods and drinks. Most of these people know SUCARYL. They know it offers true sugar-like sweetness without added calories or tell-tale bitterness.
No matter how you look at it—nationally or in terms of your own local market—SUCARYL-sweetened products are tomorrow's big plus-profit line in the food field. Make your inquiry today: Chemical Sales Division, Abbott Laboratories, North Chicago, Illinois.
Abbott
SPECIAL BOOKLET AVAILABLE!
Write today for your free copy of "Making the Most of the Dietetic Market with SUCARYL."

REGIONAL SECTION NEWS

(Continued from page 8)

Home Economics, The Ohio State University, Columbus, Ohio

Councilor: N. H. Volle, *The Kroger Co.*, Cincinnati, Ohio

Executive Committee: K. S. Chester, *Battelle Memorial Institute*, Columbus, Ohio

Dan McCoy, The Frigidaire Division, *General Motors Corporation*, Dayton, Ohio.

Robert Newton Johnson, *Buckeye Potato Chip Company*, Columbus, Ohio

Robert A. Wait, *The Procter and Gamble Company*, Cincinnati, Ohio

A. R. Winter, *Department of Poultry Science*, The Ohio State University, Columbus, Ohio

NORTHEAST SECTION

Honorary Food Technology Society honors four at University of Massachusetts ceremony. Four eminent food scientists were honored at the May meeting of the Northeast Section of the Institute of Food Technologists held at the University of Massachusetts. Recipients of certificates of Honorary Charter Membership in Phi Tau Sigma, recently founded food science honor society whose national headquarters are at the University, were Dean Samuel C. Prescott, Dr. Laurence V. Burton, Dr. Ernest C. Crocker and Professor Carl R. Fellers.

Dean Emeritus Prescott of M.I.T. is one of the pioneer food scientists whose research in the early years of the century laid the foundations for the then new

Professor Gideon E. Livingston, Phi Tau Sigma president, bestows certificates of honorary charter membership in the recently founded honorary food science society, on Dr. Laurence V. Burton, Prof. Carl R. Fellers, and Dr. Ernest C. Crocker. Prof. Ernest Lockhart (extreme right) accepted as proxy the certificate awarded Dean Samuel C. Prescott, Massachusetts Institute of Technology, who was unable to attend.

science of Food Technology. Dr. Burton, a bacteriologist by training, has had a diversified career in the food field. For many years he was an editor of *Food Industries*, a prominent publication for the food processing profession. At present, he is Director of the Packaging Institute. Dr. Burton was the featured speaker at this meeting; his address being entitled "Sense and Nonsense about Packaging." Dr. Ernest Crocker, recently retired from Arthur D. Little, Inc., consultants of Cambridge, Mass., is one of the world's leading experts in the highly specialized field of flavor analysis. Dr. Fellers, head of the Food Technology Department at the University of Massachusetts, has for years directed the active program of teaching and research in Food Technology at the University. Although recently retired as Lieutenant Colonel, Quartermaster Corps. Reserve, he still contributes to the Army the benefit of his wide experience through participation in the work of several advisory committees.

Elected *in absentia* to Honorary Charter Membership in Phi Tau Sigma, was Clarence Birdseye of Gloucester, Mass. Mr. Birdseye, at present in Peru, is the originator of the quick freezing process and of many other techniques in the food field.

OREGON SECTION

On May 8th, the Oregon Section held their annual meeting at the Schank-Gri-La Restaurant, Tillamook, Oregon.

A tour through the Tillamook Creamery preceded the luncheon. A business meeting and election of officers followed the luncheon.

Following are the 1954-55 fiscal year officers:

Chairman: H. Y. Yang, *Food Technology Department*, Oregon State College, Corvallis, Oregon

Vice Chairman: E. W. Harvey, *Seafoods Laboratory*, Astoria, Oregon

Secretary-Treasurer: C. J. Wilder, *Food Technology Department*, Oregon State College, Corvallis, Oregon

Councilor: P. R. Elliker, *Bacteriology Department*, Oregon State College, Corvallis, Oregon

Executive Committee: D. W. Turnham, *Swift & Co.*, North Portland, Oregon; Lloyd T. Stephens, *California Packing Corp.*, Portland, Oregon; H. W. Schultz, *Food Technology Department*, Oregon State College, Corvallis, Oregon; W. D. Mohney, *Libby, McNeil & Libby*, Portland, Oregon

PITTSBURGH SECTION

The 19th official meeting of the Pittsburgh Section of the Institute of Food Technologists was held May 11, 1954 at the University Club, Pittsburgh, Pa. This was the last meeting of the current year. After a very pleasant social hour and an excellent dinner, the meeting was called to order by the chairman, Mr. George Seagren.

The chairman of the Membership Committee, Mr. George Reymann, reported that there was a 25% increase in membership in the Pittsburgh Section during the past year. The new officers of the local section for next year were announced: Mr. D. W. Vaurio assumes the chairmanship after serving one year as vice-chairman. Mr. Charles Steinicke was elected vice-chairman, Mr. F. C. Barry was elected secretary-treasurer. Dr. Harold Lang was elected National Councilor, Dr. Charles R. Stumbo and Mr. Art Johnson were elected to the Executive Committee. These individuals along with our retiring chairman, Mr. George Seagren, as well as Miss Ruth Sparks and Dr. Harry J. Lipman, will serve on the Executive Committee for the Pittsburgh Section for the coming year.

Mr. V. W. Vaurio introduced the speaker of the evening, Dr. Herbert Schreibner, Industrial Products,

(Continued on page 12)

leave it to

STANGE

FOR NEW TASTE APPEAL

...SALES APPEAL

IN YOUR FINE FOODS

for 50 years
1904 • 1954
"Silent Partners in Famous Foods"

Wm. J. Stange Co
Chicago 12, Illinois • Oakland 21, California
Stange-Pemberton, Ltd., New Toronto, Ontario

PRINTED IN U. S. A.

REGIONAL SECTION NEWS

(Continued from page 10)

X-Ray Department, General Electric Company, Milwaukee, Wisconsin. Dr. Schreibner gave a very interesting and informative talk entitled "The Use of High Energy Cathode Rays in Sterilization of Food Products." Dr. Schreibner's talk brought forth a great deal of questions and answers which proved most interesting to all attending.

PUGET SOUND SECTION

The Section held its April meeting at the plant of Glaser Beverages, Inc. in Seattle, Washington, the evening of April 27. About 35 members toured the bottling works which was interesting and informative. Plant personnel pointed out the attention being paid to cleanliness and sanitary practices taken to ensure a clean, safe product. Following the tour a technical discussion of bottling techniques was held in the plant auditorium. Members and guests were invited to sample a number of the soft drink beverages bottled by this firm.

The May meeting of the Puget Sound Section was held on the afternoon and evening of May 20 at the firm of Nalley's, Inc. in Tacoma, Washington. More than fifty members and guests inspected the food manufacturing facilities at "Nalley's Valley," a local firm which produces 47 products—pickles to potato chips. Most of the afternoon was devoted to touring the several plants manufacturing and packing pickles, food canning, salad dressings, etc. Following the tours, Nalley's played host at a social period and a complimentary dinner in the firm's employee dining room. The evening program included a welcoming talk by the President of Nalley's, L. Evert Landon, and technical discussions by the following researchers from the Western Washington Experiment Station at Puyallup: Dr. Dave Almindinger, Superintendent; Dr. John Moore, Horticulturist; Dr. C. D. Schwartz, Horticulturist; Mr. John Brekke, Chemist and Food Technologist. The discussions were very enlightening to our group in demonstrating how horticultural science is improving and developing new varieties of fruits and vegetables for the producer, processor, and consumer.

PERSONNEL

Dr. Lloyd A. Hall, Technical Director of The Griffith Laboratories, Inc., Chicago, was recently elected Chairman of the Chicago Chapter, American Institute of Chemists.

Books

Modern Chemical Processes, Vol. 3. Edited by the *Editors of Industrial and Engineering Chemistry* in conjunction with the technical staffs of the cooperating organizations. Reinhold Publishing Corporation, New York (1954), 270 pages plus index.

This collection of twenty-three articles describing chemical plant processes contains information on at least five operations which food technologists will find to be related to their fields of interest.

The article on "Certified Food Colors" contains general information on color certifications, characteristics of certified food colors, and chemical properties of food colors. Production of Orange No. 1 in the Chicago plant of William J. Stange Co. is described.

"Chemicals from Milk" describes the production of casein, milk protein powder, caseinates, whey proteins, lactose, protein hydrolysates, and tyrosin at the Sheffield Farms Co., Inc. of Norwich, New York.

"Lactic Acid from Corn Sugar" is a description of the process for production of lactic acid at the Hammond, Indiana, plant of American Maize-Products Co. In addition, there is a considerable amount of general information on other processes for lactic acid production and the uses for this chemical.

The commercial production of dextran from sucrose is described and something of the history and chemistry of dextran is told in the article written in collaboration with personnel of the Commercial Solvents Corporation.

The processing of oranges to produce juice, frozen concentrate, orange oil, pectin, and hesperidin (vitamin P) is detailed in an article describing operations at the Exchange Orange Products Co., Ontario, California.

Also of interest to food technologists should be the articles on "Cellophane," "Carboxymethylcellulose," "Diotomaceous Earth," and "Animal Glue." In addition to these processes, other articles are on the subjects of: "Ammonia at 1000 Atmospheres," "An American Fischer-Tropsch Plant," "Oil Black," "Oil Gas Manufacture," "Formaldehyde from Methanol," "Hydroquinone Manufacture," "Acetophenone," "Ammonium Nitrate," "Chlorine and Caustic in Italy," "Nitric Acid in Great Britain," "Peacock Blue: Flushed Color Production," "Mercury Cell Chlorine and Caustic," "Catalytic Asphalt," and "Wulff Process Acetylene."

In general, all processes are described in terms of background, description of plant installation, description of process and operation of plants, economics of process, personnel, and future prospects.

J. H. Mitchell, Jr.
Chicago, Illinois

Storage of Cereal Grains and Their Products. Edited by J. A. Anderson and A. W. Alcock, American Association of Cereal Chemists, St. Paul, Minnesota, 1954. 515 pp. Price $11.00.

For those many people who have examined the literature in order to find ways of controlling their cereal storage problems, this A.A.C.C. monograph comes as a welcome addition to the library shelf. It is the combined effort of fifteen collaborators, each an expert in his field. In toto, these men have drawn together the many facts into a readable discussion of the problems and solutions in a remarkably error free dissertation.

The book has broader application to storage problems of foods than the limitation to cereal grains imposed by the title. The chapters on "Moisture and Its Measurement" by Hlynka and Robinson, "Microflora" by Semeniuk, "Insects" by Cotton, and "Rodents" by Spencer expose broad principles that can be applied to all foods stored in bulk. Specific examples on how these

(Continued on page 16)

DODGE & OLCOTT INVITES YOU TO

attend a christening!

IN THE AUGUST ISSUE OF FOOD TECHNOLOGY

We have given our newest line of flavoring materials its own special name... Henceforth D&O Dry Soluble Seasonings will be known as...

IN THE BEST TRADITION

of an old and historic industry, SPISORAMA Seasonings by D & O are the culmination of more than 155 years of background and experience in the spice markets of the world.

WITH A MODERN ORIENTATION

SPISORAMA Seasonings add to the finest in raw materials that essential accent on specific processing for various food applications. Skilled flavor technicians working in the most up-to-date, specially equipped plant and laboratories make the perfect integration of old and new that is SPISORAMA Seasonings.

Our 155th Year of Service

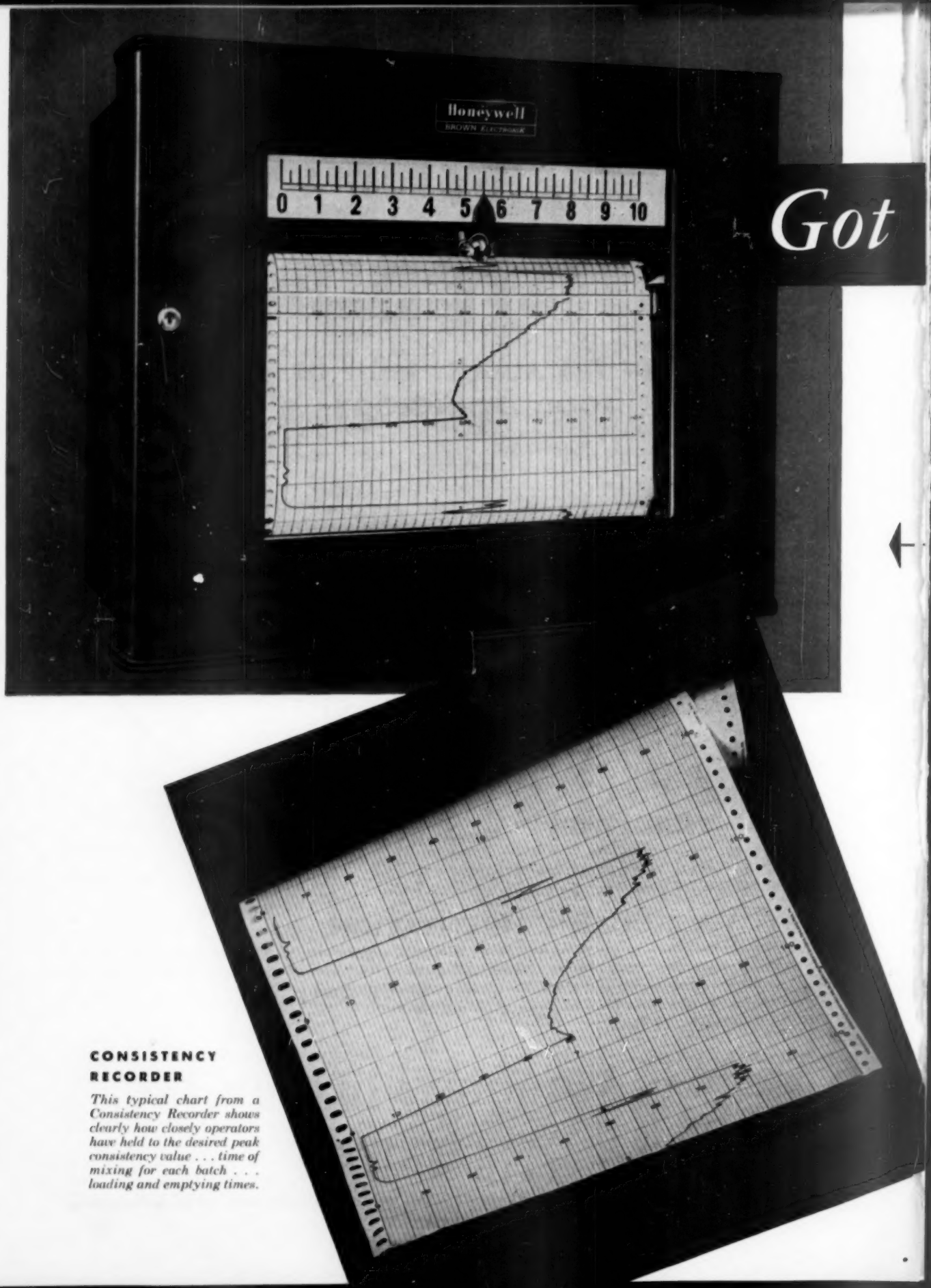
D&O ESTABLISHED 1798 ®

DODGE & OLCOTT, INC.

180 Varick Street • New York 14, N. Y.

Sales Offices in Principal Cities

ESSENTIAL OILS • AROMATIC CHEMICALS • PERFUME BASES • FLAVOR BASES • DRY SOLUBLE SEASONINGS

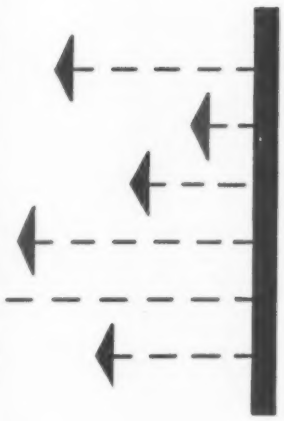


Got

CONSISTENCY RECORDER

This typical chart from a Consistency Recorder shows clearly how closely operators have held to the desired peak consistency value . . . time of mixing for each batch . . . loading and emptying times.

a mixing process?



here's an accurate, sensitive way to measure consistency

WHEN MATERIALS are mixed, it is often desirable to bring the product to a specified consistency and stop the process as soon as the optimum point is reached. Over or under-mixing may detract from the texture, grain or volume of the finished product. Marked changes in consistency may also indicate the end point of a chemical reaction, which should be allowed to proceed no further once it has reached a predetermined phase.

For these applications the *ElectroniK* Mixture Consistency Recorder offers an automatic, accurate means of continuously measuring and recording the consistency of the material in your mixer.

Measures Motor Input Power

It works on a simple principle. It measures the electrical power required to drive the mixer motor. When consistency increases, so does the drag on the motor. By recording the power input to the motor, a sensitive, readily reproducible measurement is obtained which is directly related to product consistency.

Operators find the *ElectroniK* instrument's record an easily understood index to process operation. They can see abnormal variations readily, and can tell exactly when the desired end point is reached. And management can use this same chart as a permanent record of production rates, machine stoppages and uniformity of processing.

Applicable to practically any mixer, the consistency recording system uses components that have been proved in thousands of industrial installations. Your nearby Honeywell sales engineer will be glad to discuss your specific application . . . and he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

● REFERENCE DATA: Write for Data Sheet No. 3.6-7, "Dough Mixing."

MINNEAPOLIS **Honeywell**
BROWN INSTRUMENTS
First in Controls

BOOKS

(Continued from page 12)

factors are related to chemical, physical, and nutritive changes during storage of grain and grain respiration and heating are given by Zeleny, Milner, and Geddes.

Other chapters on "Country Storage of Grain" (Barre), "Terminal Elevator Storage" (Bailey), "Drying of Grain" (Hukill), and "Flour Storage in Bulk" (Hamilton, Lynde, and Larmour) are practical, helpful discussions of how to store grain and grain products. They include sufficient design and engineering data to serve as a basis for broad decision making.

The last chapter on "Packaging and Storage of Cereal Products" by Southwick is necessarily general because of the newness of this field and the paucity of published information.

There are places in the book where vague terminology common to the cereal art but undefined for the novice is used. Thus, the terms "condition" and "soundness" of the grain are cited as factors influencing deteriorative changes—terms which mean little to the uninitiated. In another chapter, the "back leg of the elevators" and "change-off flour" are used in a context that assumes the reader is familiar with the art. This sometimes makes the reading difficult.

One comes away from this monograph with the feeling that the storage problems of cereal grains—be they mustiness, mold, insects, or heating—can be controlled by temperature, atmosphere, or moisture — and the greatest of these is moisture. The book is a true monograph, having 1094 references in the eleven chapters all relating to the storage of cereal grains and their products. It is the first in this field and should be a part of the food technologist's library.

ROBERT A. LARSEN
Minneapolis, Minnesota

FUTURE DATES FOR FOOD TECHNOLOGISTS

1954

August 9-13	Gordon Research Conferences, AAAS, *Food and Nutrition Sessions,* Colby Junior College, New London, N. H.
August 16-20	*Vitamins and Metabolism Sessions,* Colby Junior College, New London, N. H.
August 16-19	National Food Distributors, Hotel Sherman, Chicago, Ill.
August 18-31	Food Show at Cincinnati Zoo, Cincinnati, Ohio
August 30-September 1	Thirty-fourth Annual Convention, American Soybean Association, Memphis, Tenn.
September 12-17	One hundred and twenty-sixth National Meeting of the American Chemical Society, New York, N. Y.
September 13-15	American Fisheries Society, Seattle, Wash.
September 16-18	National Poultry, Butter and Egg Association, Hotel Sherman, Chicago, Ill.
October 1-6	American Bakers' Association, Chicago, Ill.
October 11-16	Dairy Industries Supply Association, Atlantic City, N. J.
November 15-18	International Soft Drink Industry Exposition, Convention Hall, Philadelphia, Penna.
June 12-16, 1955	**Institute of Food Technologists, Deshler-Hilton Hotel, Columbus, Ohio**

(Information concerning future dates of national and international meetings, conventions and exhibits of interest to food technologists should be sent to the editorial office.)

Recently Elected Members of IFT

Everett L. Ackley
Hines-Park Foods, Inc.
416 E. State St.
Ithaca, N. Y.

Cortlandt F. Ames
James Dole Engineering Co.
582 Sutter St.
San Francisco, Calif.

Dr. Arthur W. Anderson
Dept. of Bact. & Hygiene
Oregon State College
Corvallis, Ore.

Malcolm W. Browne
53 W. 71st St.
New York 23, N. Y.

Leslie M. Burgess
736 N. Myers St.
Burbank, Calif.

George W. Courtney
Van Camp Sea Food Co.
772 Tuna Street
Terminal Island, Calif.

Anthony W. Daly
1506-45th Ave.
San Francisco 22, Calif.

John O. Diehl
Sun Garden Packing Co.
P. O. Box 1089
San Jose, Calif.

L. Corbin Eddison
4147 Rose Ave.
Western Springs, Ill.

John H. Feigell
Spicene Co. of America
6015 Broadway
West New York, N. J.

August F. Glaive
2022 California St.
Berkeley 3, Calif.

Milton E. Griem
7120 N. Beach Dr.
Milwaukee 17, Wis.

Marion Hildebrandt
Hallmark Testing Service
Div. of Safeway Stores
4th & Jackson
Oakland, Calif.

W. Lewis Jones
W. S. Kimpton & Sons
Arden St.
Kensington, Vic., Australia

S. Norman Kahn
Spicene Co. of America Inc.
6015 Broadway
West New York, N. J.

C. F. Kleyn
951 N. Martel Ave.
Los Angeles 46, Calif.

Samuel Klein
100 Beekman Street
New York 38, N. Y.

Carl G. Peterson
6083 Estates Dr.
Oakland 11, Calif.

Martha A. Poolton, Home Econ.
Washington Coop. Farmers Ass'n
201 Elliott Ave. W.
Seattle 99, Wash.

Gus H. Rapaport
1249 W. 67th St.
Kansas City 13, Mo.

Theodore L. Roth
P. O. Box 136
Stanton, Calif.

Dr. Martin W. Shookhoff
Fries & Fries Inc.
110 E. 70th St.
Cincinnati 16, Ohio

Floyd H. Stadtman
P. O. Box 614
Davis, Calif.

Alfred Stauder
1 Bendigo Ave.
Elwood S. 3
Melbourne, Vic., Australia

STUDENTS

Dennis F. Abe
Univ. of Maryland, Hort. Dept.
College Park, Md.

F. A. Bettelheim
Dept of Food Tech.
Univ. of California
Davis, Calif.

Salah Darhous
Univ. of Maryland, Hort. Dept.
College Park, Md.

Selected Abstracts*

ANALYTICAL METHODS

Moisture determination in a circulating refrigerant.

Tech. News Bull., 38, 59-61 (1954).

A simple, rapid method for detg. the H_2O content of a circulating refrigerant of the fluorocarbon group was developed. Based on the change in elec. resistance of an electrolytic film as

* These Selected Abstracts are made available to FOOD TECHNOLOGY through the cooperation of Associate Editor H. A. Campbell and the General Foods Corporation of New York, N. Y. The abbreviations found in these abstracts are similar to those used by Chemical Abstracts.

(Continued on page 18)

ANSWER TO LEAVENING PROBLEMS Family Style

A FAMILY OF FOUR PROVED MONSANTO PRODUCTS ARE READY TO MEET YOUR LEAVENING NEEDS:

Monsanto SAPP-40 . . . ideal for machine doughnut mixes. Gives a fine texture and crust. Reduces tunnels. Cuts down on grease absorption, improves doughnut's shape. Here is a product that gives uniform action—every time.

Monsanto SAPP-28 . . . a slow-action baking acid, especially suited for cakes, biscuits, muffins. Has beneficial effect on gluten in flour; imparts greater extensibility and higher gas retention.

Monsanto HT Phosphate (MCP Monohydrate) . . . versatile, effective, contains no free phosphoric acid, hence does not attract moisture and cause premature reaction with soda. Use it alone or in combination with other Monsanto leavening agents for good results.

Monsanto PY-RAN (MCP Anhydrous) . . . for stability never before possible in self-rising flour and cake mixes. PY-RAN gives a slow, controlled gas release during first two minutes of the mixing of the dough or batter. Tests clearly prove PY-RAN releases CO_2 slowly during first two minutes of the mixing of the dough or batter. This two-minute reading is especially important, as any CO_2 evolved during this time will be unavailable for leavening action in the oven.

MONSANTO

For more information or a copy of the new booklet, "Monsanto Phosphate Leavening Agents," write to MONSANTO CHEMICAL COMPANY, Inorganic Chemicals Division, 1700 South Second Street, St. Louis 4, Missouri.

PY-RAN: *Reg. U. S. Pat. Off.*

SERVING INDUSTRY...WHICH SERVES MANKIND

SELECTED ABSTRACTS

(Continued from page 16)

it absorbs H_2O vapor, the method is an application of the elec. cond. method for detg. H_2O vapor in gases.

Determination of lead in foodstuffs.

LOCKWOOD, H. C. *Analyst, 79,* 143-6 (1954).

A method for the detn. of lead in foodstuffs, based on extn. of the dissolved ash with a soln. of diethylammonium diethyldithiocarbamate in CCl_4 at a pH of 7.0, is suggested. Ca and Mg phosphates do not interfere. The complex is decompd. with acids and the lead is detd. by extractive titration with a 0.0035% soln. of dithizone in $CHCl_3$. The method is more accurate than the usual sulfide technic and more convenient than the absorptiometric method with dithizone solns.

Determination of the phosphorus content of lipids.

HARRIS, W. D. *J. Am. Oil Chemists' Soc., 31,* 124-7 (1954).

A no. of Mo blue procedures were investigated, and a method was developed for the detn. of P in cottonseed lipids which considerably reduces the effect of variables. The method utilizes perchloric acid for sample digestion and *p*-methyl-amino-phenol sulfate as a reducing agent for color development.

BIOLOGICAL SCIENCES

BIOCHEMISTRY

Conformation changes of proteins.

LUMRY, R., AND EYRING, H. *J. Phys. Chem., 58,* 110-20 (1954).

A summary of the newer evidence on what takes place when a protein undergoes structural change i.e., "denaturation." Hydration and folding are discussed as well as recent changes in the concept of enzymic catalysis.

Interaction of pepsin and proteins.

GOLDFARB, A. R. *Arch. Biochem. Biophys., 49,* 179-86 (1954).

Egg albumin, bovine albumin, and gelatin give ppts. with pepsin at a pH near 4.0. The complex of bovine serum albumin and pepsin consists of equimolar amts. of each component at molar ratios of albumin/pepsin up to unity. In excess albumin, the amt. of albumin in the complex increases.

A study of the interaction of dodecyl sulfate with bovine serum albumin.

PALLANSCH, M. J., AND BRIGGS, D. R. *J. Am. Chem. Soc., 76,* 1396-1403 (1954).

Evidence is presented that the protein mols. are not equally susceptible to the action of initially bound detergent in causing the change in phys. form which is accompanied by the change in interaction capacity.

MICROBIOLOGY

Availability of amino acids to microorganisms. II. A rapid microbial method of determining protein value.

HORN, M. J., BLUM, A. E., AND WOMACK, M. *J. Nutrition, 52,* 375-81 (1954).

The method is based on the observation that the sum of the available amino acids dets. the amt. of growth of the microorganism. Since no amino acids are used in the basal medium, the method is relatively inexpensive and results can be obtained in a short time.

Coliforms in ice cream require cautious interpretation.

BARTSCH, W. C. *Southern Dairy Products J., 54,* 51° (1953); *Biol. Abstr., 28,* 405, No. 4088 (1954).

Approx. 861 processing-line samples of mix and ice cream were analyzed for coliform organisms. Coliform organisms survived pasteurization at 165° for 30 min. in small nos. about 10% of the time. The reason for their survival was the inability of the heat to penetrate the foam during pasteurization. Subsequent conditions of handling and storage increased the incidence of coliform organisms in the finished ice cream to approx. 40%.

A quantitative method for determining the bacterial contamination of dishes.

GUITERAS, A. F., FLETT, L. H., AND SHAPIRO, R. L. *Appl. Microbiol., 2,* 100-1 (1954).

A quant. estn. of contamination not attainable by previous methods is claimed.

NUTRITION

A study of the utilization of ascorbic acid as shown by the physiological response of human subjects.

FISHER, K. H. Doctoral Thesis Penn. State Univ.; *J. Home Econ., 46,* 205-6 (1954).

The total ascorbic acid from tomato juice, green beans, lima beans, brussel sprouts, and orange juice was utilized equally as well as the synthetic vitamin. The subjects, fed a single and divided intake at two levels, 75 and 150 mg. ascorbic acid for 37 days, showed no significant difference in the vitamin utilization. The subjects with previous low (30 mg.) or high (150 mg.) vitamin intake showed a carry-over effect in blood plasma for 23 days on 60 mg. test level.

A comparison of the retention of vitamin A in margarines and in butters based upon bioassays.

DEUEL, H. J., AND GREENBERG, S. M. *Food Research, 18,* 497-503 (1953).

No differences were noted in the retention of vitamin A in margarines, irrespective of whether the vitamin added was in the form of the alc., the distd. esters, or the natural esters. The av. original vitamin A content of the 8 margarines was 42.9 units per g.

Effect of emulsifiers on fat absorption in the normal young adult.

TIDWELL, H. C., AND NAGLER, M. E. *Gastroenterology, 23,* 470-6 (1953); *Chem. Abst., 48,* 1503d (1954).

No definite alterations in the chylomicron curves or the areas beneath them were produced in normal young men when the ingested fat was supplemented with an exogenous emulsifier or replaced with split fat. This indicated a similar rate of fat absorption in the subjects under these conditions. Neither Tween 80 nor glycerol monooleate, when fed to rats as a 6% supplement to a standard fat meal, appeared to influence the rate of fat absorption as measured by recovery of the unabsorbed fat.

Aspects of protein nutrition need more research.

GRAU, C. R. *Western Feed and Seed, 8(6),* 23° (1953); *Biol. Abstr., 28,* 617, No. 6199 (1954).

In animal nutrition it is necessary to know the economic max. amt. of an amino acid needed as contrasted with the amt. for max. gain. The requirement for one amino acid is also a function of the amt. of other amino acids present. Tests for amino acid quality in soybean oil meal are being developed. There is great variability in feeding value of protein concentrates. To date only feeding trials give an accurate measure of the value of any one lot of concentrate.

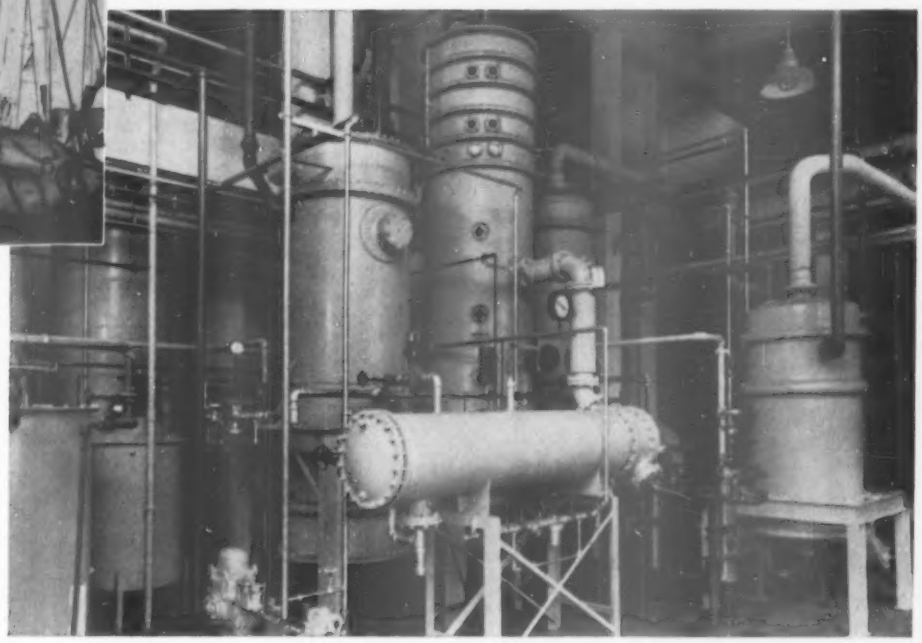
Effect of age on the utilization of various carbohydrates by man.

ALBANESE, A. A., HIGGONS, R. A., ORTO, L., BELMONT, A., AND DILALLO, R. *Metabolism, Clin. and Exptl., 3,* 154-9 (1954).

These studies reveal that the utilization of dextrose decreases markedly with age, whereas the utilization of fructose is only slightly affected by the age of the individual. The results of these studies carry the suggestion that fructose or fructose-contg. products are the sugars of choice for the aged in that they may provide a ready source of energy and an optimal protein-sparing effect.

(Continued on page 20)

Spice Shipments are not always the same...



BUT CONTROLLED EXTRACTION ASSURES UNIFORMLY PURE, POTENT PEPPER FLAVOR IN SOLUBLIZED Pepperoyal®

Pepperoyal is no ordinary soluble pepper. Use the same amount of Pepperoyal in every batch of your product, and every batch will smack of the same pure pepper flavor.

True, it is processed from prime quality pepper berries. But, its real quality distinction originates in the Griffith laboratories. The potency, purity and uniformity of pepper flavor in Pepperoyal is controlled by our exclusive process of extraction.* It assures you of the same flavor quality in every shipment of Pepperoyal, or any of Griffith's Solublized Seasonings.

A real contribution to the flavor control of your products! Let's talk about it.

*Patent Applied For.

THE Griffith LABORATORIES, INC.

In Canada — The Griffith Laboratories, Ltd.

CHICAGO 9, 1415 W. 37th St. • NEWARK 5, 37 Empire St. • LOS ANGELES 58, 4900 Gifford Ave. • TORONTO 2, 115 George St.
Laboratorios Griffith do Brasil, S.A.—Caixa Postal 300 Mogi das Cruzes, Est. S. P., Brasil

SELECTED ABSTRACTS

(Continued from page 18)

Mode of action of antibiotics in swine nutrition. I. Effect of feeding antibiotics on blood glucose.

CATRON, D. V., LANE, M. D., QUINN, L. Y., ASHTON, G. C., AND MADDOCK, H. M. *Antibiotics and Chemotherapy, 3,* 571-7 (1953); *Biol. Abstr., 28,* 362, No. 3722 (1954).

Three possible explanations for the apparent effect of aureomycin feeding on blood glucose changes are: changes in the intestinal flora resulting in more glucose being available for absorption; changes in the structure of the absorptive tissue of the gastro-intestinal tract allowing a faster absorption of glucose; and/or changes in the metabolism of the animal resulting in higher blood-glucose levels after oral ingestion of glucose.

Maximum sodium chloride intake and thirst in domesticated and wild Norway rats.

RICHTER, C. P., AND MOSIER, H. D.. *Am. J. Physiol., 176,* 213-22 (1954).

The ingestion of large amts. of salt over 2-3 mos. time did not produce any visible dietary deficiencies, nor did it produce any detectable pathological changes in the kidneys. When given access to H_2O, rats will freely eat diets contg. as much as 35% salt; they will eat fair amts. of a diet contg. 50-70% salt. On the basis of the results of these expts. it was suggested that difficulties encountered by man in using salt may result from failure, for cultural and social reasons, to drink adequate amts. of H_2O for excreting the excess of salt ingested.

PHYSIOLOGY AND MEDICINE

Experimental dental caries. V. The effects of desalivation and castration on caries and fluorine storage in the rat.

BIXLER, D., MUHLER, J. C., AND SHAFER, W. G. *J. Nutrition, 52,* 345-53 (1954).

Desalivation resulted in a marked increase in the incidence and severity of dental caries. Castration, on the other hand, in both sexes reduced caries development significantly. F_2 storage under ad libitum feeding conditions indicated less F_2 in both males and females in the skeletons of the desalivated, castrated or combined desalivated-castrated groups, but under paired-feeding condns. the differences in F_2 storage between the desalivated and control groups disappeared.

The total cholesterol-lipid phosphorus ratio.

GERTLER, M. M., AND OPPENHEIMER, B. S. *Geriatrics, 9,* 157-62 (1954).

Evidence is presented supporting the thesis that the total cholesterol/lipid phosphorus is a good index to atherosclerogenesis in males.

Recent contributions to the understanding of the metabolic defect in gout.

DEWITT, S. *Geriatrics, 9,* 163-71 (1954).

A plausible explanation may be offered to account, in certain cases, for the increased size of the miscible pool of uric acid in gout. Isotope data suggest that this exaggeration is a consequence of a shunt so that uric acid is formed from precursors of dietary origin. The operation of such a shunt, which may be a normal metabolic route in birds, may result in man in the undue accumulation of uric acid in the body.

Effects of extremes of temperature on hypertensive rats.

FREGLY, M. J. *Am. J. Physiol., 176,* 275-81 (1954).

Hypertensive rats were found to survive exposure to extremes of temp. less well than control rats, and to have a generally limited ability to adjust to unfavorable conditions.

Heat death.

HEILBRUNN, L. V. *Sci. American, 190,* 70-5, April, 1954.

No animal, whether man, mouse or insect, can survive body temps. a few degrees above normal. The reason is traced to the living cell, where melting of fat dets. the clotting and death of protoplasm.

ENGINEERING AND PLANT EQUIPMENT

Metering flow.

CUSICK, C. F. *Instrumentation, 7,* 42 (1954).

Among the many ways of measuring flow, the inferential head or differential pressure method is most widely used. The material presented is intended to be of help in selecting the best primary device for a specific application.

Liquid-liquid extraction, a critical survey of the literature dealing with the mechanism of transfer of solutes across phase boundaries with special reference to liquid-liquid interfaces. PB112807.

LEWIS, J. B. *Bibliog. Tech. Repts., 21,* 9 (1954).

The literature dealing with the theory of mass transfer between two liquid phases is critically examd. The analogous cases of mass transfer in solid-liquid and in gas-liquid systems, and of heat transfer, are also considered. The properties of ions at the interface are reviewed.

Gaskets.

ELONKA, S. *Power, 98,* 105-24, March, 1954.

A very thorough presentation on the use of gaskets for various purposes. Included are uses for stationary and moving parts and a table which indicates the optimum conditions for various gasketing materials.

FOOD AND FOOD TECHNOLOGY

CHEMICALS IN FOODS

Proof required to establish the safety of a chemical additive for use in food.

BRENNAN, B. W. *Food, Drug, Cosmetic Law J., 8,* 561-9 (1953).

Some of the phases discussed are: reports which should be available to the evaluating body; necessity for both oral and intravenous administration of chemicals; and studying diets for subacute and chronic toxicity effects.

EMULSIFICATION AND EMULSIFIERS

Ultrasonic emulsification and homogenization.

ROSE, F. *..Food in Canada, 14,* 11-12, March, 1954.

The economics and method of producing emulsions are discussed. A high velocity jet and a vibrating blade are used.

Emulsifiers for 1954.

Agr. Chemicals, 8, 48-51+, November, 1953; *Battelle Tech. Rev., 3,* 71a, No. 1576 (1954).

A review of the characteristics of some new and old materials. Includes suggestions on selection of emulsifying agent for each application and how to formulate properly to assure optimum results in the field.

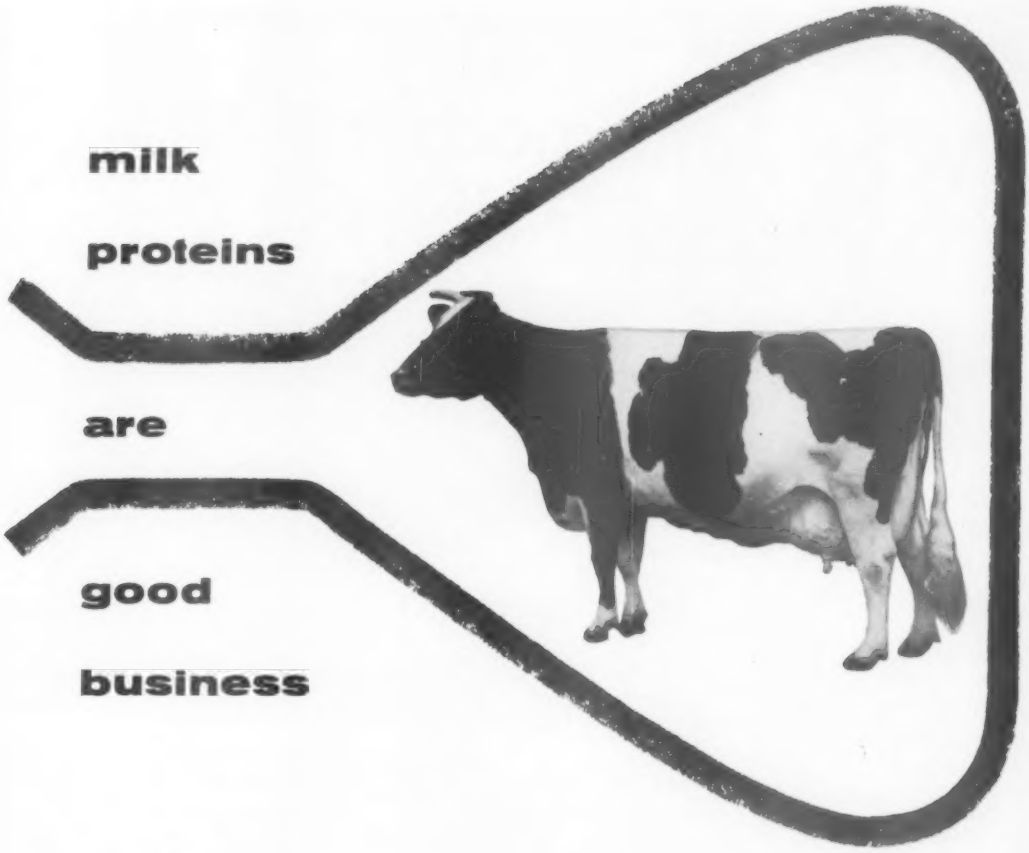
FEEDINGSTUFFS

Vitamin stabilization: effect of added stabilized animal fats on stability of vitamin A in feeds.

SIDLER, A. J., AND SCHWEIGERT, B. S. *J. Agr. Food Chem., 2,* 193-5 (1954).

When 6% stabilized animal fat was added to com. feeds, the stability of vitamin A was increased when the fat was stored at room temp. The increase was noted primarily in the later phases of storage periods. In addn. to increased stability of vitamin A, addn. of stabilized animal fats increases feed efficiency, decreases dustiness of the feed and improves appearance.

(Continued on page 24)



Today, the public is becoming more and more aware of the need for lower calorie, tissue building, higher protein containing foods for everyone, particularly grownups and the ever-expanding old-age groups. Processors of food products can cash in on this interest by increasing and improving on the protein content of their products with Sheffield milk proteins.

Ice cream, baking, cereal, infant food and meat processors are finding milk proteins a highly desirable supplement to their products. Nature has built extra values into milk proteins, and Sheffield brings these extra values to you. As an example, Sheffield milk proteins are outstanding in nutritional quality because of the fine balance of all essential amino acids.

Sheffield guards the quality of its milk proteins through complete control of the process from farm-fresh milk to the finished product . . . and Sheffield makes these proteins available to you in a wide variety of forms, with characteristics to suit your needs.

Consider these advantages of Sheffield milk proteins: they are fat-free, pleasing to taste, variable in protein content, white in color, and many are sodium-free. In addition, they can serve as excellent dispersing, stabilizing and water-binding agents in many foods. Of course, all meet applicable Federal Food and Drug regulations.

Milk proteins are only one of many products of Sheffield research, all directed toward supplying food processing manufacturers with superior ingredients. Our research department will gladly work with your laboratories to develop new products or improve old ones. For detailed information write Sheffield Chemical Company, Inc., Food Division, Norwich, N. Y.—or to our branch office at 1267 Sixth Ave., New York 19, N. Y.

SHEFFIELD

MILK PROTEIN EDIBLE POWDER
HIGH NITROGEN CASEIN
SODIUM CASEINATE POWDER
CALCIUM CASEINATE POWDER

LEADS THE FIELD IN MILK PROTEINS

A DIVISION OF NATIONAL DAIRY PRODUCTS CORPORATION

Why don't people stick to their diets?

Some diets fail because they are based on fads

Even good diets fail when people don't stick to them

Why don't people stick to their diets?

Because they can't overcome that "always hungry" feeling

Why are they hungry?

It may be because their blood sugar level is low

Have you put aside your scale because your diet was too dreary?

The fastest way to raise your blood sugar level, keep your appetite satisfied with less, is to have some sugar—or one of the good things containing it.

A new approach to diet planning, based on recent research, helps healthy people hold down their waistlines by raising the blood sugar level.

People have such a natural liking for sugar, it has always been one of the foods hardest to do without.

Now science finds that there is no need for any healthy person to do without sugar. In fact, your normal use of sugar may actually be helping to *keep you from gaining weight.* And if you want to lose weight, a moderate use of sugar as part of a well-planned diet can actually make it much easier for you to stick to your diet.

Why does eating a sweet just before a meal help keep you from eating too much?

Why does a simple dessert make a small meal so much more satisfying?

Science finds the reason

That's because sugar raises your *blood sugar level* faster than any other food. New research at a leading university has shown that the blood sugar level plays a leading role in regulating appetite.

When the blood sugar level falls too low, the appetite regulating center of the brain (the hypothalamus or "appestat") turns on the appetite much as a thermostat turns on the furnace in your house. You're apt to eat more than you need, without being conscious of overeating, before your blood sugar level is raised to the point where it "shuts off your appestat."

New way to diet without hunger

This discovery has already brought about an entirely new approach to weight control diets. It is based on keeping hunger *down* by keeping your blood sugar level *up* throughout the day.

You do not cut out any food, you simply *cut down.* To make it easier to cut down, you eat more often—with small mid-morning, mid-afternoon and bedtime snacks if you are hungry. But in all you do not eat nearly so much. You do not want so much.

You do not substitute artificial, no-calorie sweeteners for sugar. They can't help curb your appetite since they have no effect on your blood sugar level. Using them defeats your purpose.

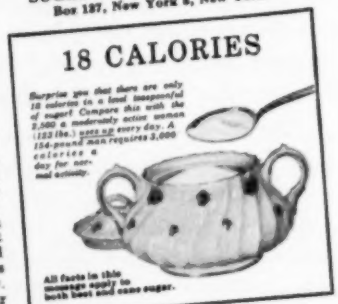
You may have a teaspoonful of sugar in your coffee or tea, or on your breakfast cereal or fruit. It supplies only 18 calories, can make it easier for you to turn down second helpings that would supply several times as many calories.

Because it makes a small meal so much more satisfying, you may eat desserts that include sugar with your lunch or dinner. And you may have an occasional between-meals sweet such as a soft drink or piece of candy. This is one of the *fastest* ways to satisfy your craving for food with the *fewest* calories.

More facts for weight watchers

Scientific articles on the blood sugar level studies have been published just recently in Medical Journals. But already many popular magazines have begun to pick up the story with articles that show how you can have your sugar and your waistline, too. One of these recently appeared in *Reader's Digest.* If you would like a reprint of this article, plus other interesting facts about sugar write to:

SUGAR INFORMATION, INC.
Box 127, New York 8, New York


18 CALORIES
Surprise you that there are only 18 calories in a level teaspoonful of sugar? Compare this with the 2,500 a moderately active woman (122 lbs.) gets up every day. A 154-pound man requires 3,000 calories a day for normal activity.
All foods in this message apply to both beet and cane sugar.

THE THIRD AD in Sugar's New Campaign faces up to the big problem faced by most reducers—how to stick to their diets.

It appears in LIFE—July 12, THE SATURDAY EVENING POST—July 24, LADIES HOME JOURNAL—August, NEW YORKER—August 21—LOOK, August 24.

It also appears in 39 leading metropolitan newspapers the week of July 5.

NEW TREND

Dieters are now being told, "Stay with Sugar—the real article. It's nature's real aid to weight control"

Sometimes new ideas about a product catch on gradually.

Sometimes they spread like wildfire.

That's what's happening now on sugar.

A year ago, the facts about sugar's new-found role in appetite and weight control were known only to a small circle of nutritional research people.

Since the start of the Sugar Industry's advertising program, millions of healthy people have learned that they can be slim and still enjoy sugar.

This program is just beginning to roll, but it's already been acclaimed as one of the outstanding food campaigns of recent times. It has won the support of all quarters of the food and beverage industry.

One reason is that there never was news of greater importance about *any* food product—news that affected *so many* products—news that people were more anxious to hear or ready to believe.

Another reason is that the discovery on which this advertising is based has started a new trend in diet planning. New, easier-to-stick-to diets, now beginning to appear in magazines and newspapers, give greater prominence to sugar-containing foods and beverages.

This new trend will do much to help shape new, more favorable attitudes about the foods you make, distribute or sell.

SUGAR INFORMATION, INC.
New York 5, New York

CUT SEASONING COSTS

20% to 40%

MAGNA spice concentrols — scientific formulations of spice essential oils and oleoresins . . . the most concentrated flavoring materials available.

advantages:

- 100% pure, natural products obtained by distillation or extraction from *actual* leaves, herbs, roots, buds or berries.
- Contain no diluents or inert materials of any kind.
- More economical because they are more concentrated, yet readily diluted in your own plant.

Write for your copy of "Questions and Answers" for the food processor. Learn how the development of Magna Spice Concentrols has modernized the seasoning of food products . . . and cut seasoning costs.

MAGNUS, MABEE & REYNARD, INC.

Since 1895 • One of the world's greatest suppliers of essential oils

16 Desbrosses Street, New York 13, N. Y. • 251 North La Salle Street, Chicago 1, Ill.

SELECTED ABSTRACTS

(Continued from page 20)

FISH AND SEAFOOD

Fish flour for human consumption.

DREOSTI, G. M. *Fish. Ind. Research Inst. 6th Ann. Rept.*, 25 (1954).

It was found possible to produce light colored flours, not quite as light as white fish flour, which were sufficiently free from odor and flavor to remain undetected when incorporated in brown bread to the extent of 4%, based on the wt. of wheat flour used.

PESTICIDES

Pesticide research and control.

CHESTER, K. S. *Battelle Tech. Rev., 3*, 16-21 (1954).

The conventional types of agricultural chemicals and the potentialities of entirely new types are discussed. Among those mentioned are chemicals that will impart new qualities to plants, guide plant physiological activities to greater productivity, regulate growth and alter plant growth habits. The problems of development of these new pesticides also are discussed with emphasis placed on costs of toxicological studies.

PRESERVATION

Sorbic acid as a fungistatic agent for foods. I. Harmlessness of sorbic acid as a dietary component.

DEUEL, H. J., ALFIN-SLATER, R., WEIL, C. S., AND SMYTH, H. F. *Food Research, 19*, 1-12 (1954).

Exptl. results are presented which indicate that sorbic acid is harmless to rats and to dogs when incorporated in the diets to the extent of 5% dry basis. The results of the expts. indicate that sorbic acid is actually far less toxic than the commonly used sodium benzoate.

Sorbic acid as a fungistatic agent for foods. II. Metabolism of α,β-unsaturated fatty acids with emphasis on sorbic acid.

DEUEL, H. J., CALBERT, C. E., ANISFELD, L., MCKEEHAN, H., AND BLUNDEN, H. D. *Food Research, 19*, 13-19 (1954).

The intermediary metabolism of sorbic acid is shown to be identical with the metabolism of the normally occurring fatty acids, caproic and butyric.

Sorbic acid as a fungistatic agent for foods. III. Spectrophotometric determination of sorbic acid in cheese and cheese wrappers.

MELNICK, D., AND LUCKMANN, F. H. *Food Research, 19*, 20-7 (1954).

This paper presents a method for the estn. of sorbic acid in cheese and in cheese wrappers. The sorbic acid is distd. at atm. pressure and the sorbic acid in the distillate is identified by its characteristic u.v. absorption curve. The $E_{1}^{1\%}$ cm. value at the absorption max. of 262 mμ is 2200 $\pm$ 3%.

Sorbic acid as a fungistatic agent for foods. IV. Migration of sorbic acid from wrapper into cheese.

MELNICK, D., AND LUCKMANN, F. H. *Food Research, 19*, 28-32 (1954).

Sorbic acid was found to migrate rapidly from the cheese wrapper and the cheese. After a few days storage at 45° F., better than 90% of the sorbic acid had migrated from the wrapper into the cheese.

Sorbic acid as a fungistatic agent for foods. VII. Effectiveness of sorbic acid in protecting cheese.

SMITH, D. P., AND ROLLIN, N. J. *Food Research, 19*, 59-65 (1954).

The application of 2.5-5.0 g. of sorbic acid/1000 sq. in. of cellophane gave a wrapper suitable for the control of mold in process or natural American cheese. Taste tests of cheese contg.

(Continued on page 28 following technical papers)

Comparisons of the Quality and Stability of Whole Egg Powders Desugared by the Yeast and Enzyme Methods

LEO KLINE,* T. T. SONODA, AND HELEN L. HANSON

Western Utilization Research Branch, Agricultural Research Service, United States Department of Agriculture, Albany 6, California

(Manuscript received March 6, 1954)

Enzyme- and yeast-desugared whole-egg solids were examined by chemical methods for changes induced by processing. The comparative initial qualities of the two powders were determined by baking performance, trained-panel evaluation, and consumer-type preference testing. The relative stabilities of the two powders were appraised by the same methods after storage at 100° F.

The role of glucose in the instability of whole-egg powder and the application of resting-cell yeast fermentation to remove the glucose before drying have been described in previous reports *(10, 11)*. The present report is concerned with an appraisal of the more recently introduced enzymatic method (glucose oxidase) for the preparation of glucose-free whole-egg powders and with comparisons of the initial quality and stability of such powders with those prepared by the yeast method. These comparisons were considered advisable, because the two desugared powders differed noticeably in their initial physical properties and performance value.

EXPERIMENTAL

Preparation of glucose-free whole-egg powders. Properties of glucose oxidase and factors affecting its activity have been described by British investigators, Coulthard *et al. (3)* and Keilin and Hartree *(8)*, among others. The commercial preparations of purified glucose oxidase available during the course of these studies were in solution and also contained catalase and about 30% of glucose as a stabilizer. (The value of glucose in stabilizing solutions of glucose oxidase was pointed out by the British investigators named above.) The catalase, used in conjunction with added hydrogen peroxide, provides a convenient source of oxygen for the desugaring reaction and also, of course, decomposes that hydrogen peroxide which arises from the enzymatic oxidation of glucose.

The conditions chosen for the desugaring of whole-egg melange by the enzyme process were those optimum for completing the reaction within 2.5 to 3 hours, a time consistent with economy of enzyme use, control of microbial contamination, and scheduling of plant operations. These conditions were as follows:

The temperature of egg pulp during the reaction was generally held at 86° to 95° F. (30° to 35° C.). Two pounds of enzyme solution containing approximately 150,000 commercial Sarett units of activity were added per 1,000 pounds of egg pulp. Hydrogen peroxide was added as a source of O_2 at a level of 5 lbs. of 35% H_2O_2 per 1,000 lbs. of whole egg pulp; this addition was made either continuously or at 15- minute intervals during the reaction period. Continuous addition with mild agitation was found to minimize foaming when the desugaring process was carried out in deep vats. In those cases where the H_2O_2 was added at intervals by hand, it was convenient to dilute it 4-fold to minimize the skin irritation hazard. Also in such cases the pulp was stirred for about one-half minute after each peroxide addition.

The endpoint of the enzyme desugaring process was determined by the quick-test adaptation of the Somogyi analytical method for reducing sugar *(10)*. This quick test, which gives a clear endpoint when used with the yeast desugaring method, was found to yield a persistent residual trace turbidity at the completion of the enzyme procedure. As is discussed later, this is caused by the fact that removal of reducing sugars by the enzyme method is slightly less complete than by the yeast method. The endpoint with the enzyme-desugaring procedure was therefore appraised by obtaining two successive tests which gave about the same trace turbidity.

Desugaring by the yeast method was carried out as follows: 1.5 to 2 lbs. of fresh commercial pressed bakers' yeast were added to each 1,000 lbs. of whole egg pulp after first macerating the yeast with sufficient water to form a slurry. As estimated by the potato-dextrose-agar plate count *(2)*, this addition represented a concentration of 15 to 20 x 10^6 yeast cells per ml. of egg pulp. Greater yeast concentrations were avoided, because the residual off-flavor rose rapidly above this level. The temperature of the pulp was adjusted to 88° to 92° F. (about 32° C.) either before or after the yeast addition. Stirring was generally confined to a period of about 15 minutes after the yeast addition; any additional stirring was very mild and designed not to interfere with the essentially anaerobic conditions of the resting cell fermentation. Under those conditions, the desugaring process was completed in about 2.5 hours.

A variation of the yeast process designed to yield glucose-free powder with a reconstituted pH of 7.0 to 7.2 (in contrast to the usual 8.6 to 9.0) was carried out either by the addition of a definite amount of concentrated hydrochloric acid (2.38 lbs. ACS reagent grade HCl, diluted 1:10 with water, was added per 1,000 lbs. of egg pulp) at any time prior to pasteurizing and drying, or by adjustment of the pH of the whole egg pulp to 6.25 to 6.35 with the diluted hydrochloric acid before, but not during or after, the yeast treatment.

Both the enzyme- and yeast-desugared pulps were pasteurized at 140° to 142° F. (60° to 61° C.) for 3 minutes and spray-dried in commercial equipment. The powders were cooled to 80° F. (27° C.) immediately after drying and gas-packed (N_2) in hermetically sealed cans which were held at 0° F. (—17.7° C.) or below until storage or other evaluation studies were initiated. Where comparisons of different types of whole-egg powders were made, the powders were prepared from the same or comparable parent egg melange.

Organoleptic and baking performance evaluations. The technique by which the degree of storage off-flavor development is appraised by trained taste panels in scrambled eggs, and in which the scores assigned are independent of mild initial foreign flavors, has been previously described *(6, 12)*. The trained-panel method as used was therefore a useful measure of flavor stability (i.e., degree of change from control) but did not necessarily measure total off-flavor or reflect consumer acceptability.

Consumer preference evaluations were made by the paired comparison method *(5, 15)* and were designed to determine which of any 2 types of dried egg was preferred by individuals untrained in judging eggs. Three pairs of samples of scrambled eggs were presented in succession to each judge. Each sample consisted of a half-ounce portion of scrambled egg. In contrast to the scrambled eggs served in the trained panel evaluations, which were prepared from water and egg powder alone, the present samples contained (in addition) milk, seasonings and shortening. Each judge was asked to record the code mark of the sample in the pair that he preferred or to indicate that he had no preference, and he was also invited to comment on characteristics such as flavor, appearance, texture, and odor. The order of presentation of samples was randomized. Forty judges

* Present address: Research Laboratories, Kraft Foods Co., Glenview, Illinois.

were used for each test, thus giving 40 responses for each pair of samples. The individuals serving as judges were chosen from the laboratory staff; excluded were those who (a) had been trained to judge eggs, (b) were technically familiar with the product, (c) had any particular knowledge or interest in the experiment, or (d) had a strong dislike for scrambled eggs.

Baking performance was evaluated by the sponge cake method previously described *(11)* in which the sugar-egg foam is formed by beating at an elevated temperature (40° C.).

Chemical measurements. [b] Methods used to measure protein solubility, amino-nitrogen, lipid and salt fluorescence, reducing-sugar and lipid absorbancy have been previously described *(11, 12)*. Total carotenoids in whole egg powder were determined by spectrophotometric analysis of the ether extracts as described by Dutton and Edwards *(4)*. Sulfhydryl-group assays were performed [b] according to a *p*-chloromercuribenzoate method previously described by him *(14)*. Peroxides in the lipids of whole egg powders were determined by shaking 5 g. of powder with 25 ml. of chloroform for one hour, filtering and measuring the peroxide in 8 ml. of filtrate (containing about 0.7 g. extracted oil) by a modified Wheeler method *(19)*. Volatile acids were determined according to the A.O.A.C. method *(1)*.

RESULTS AND DISCUSSION

Residual reducing sugar in enzyme-processed powders. After a number of laboratory and commercial-scale tests, we have found that use of glucose oxidase for desugaring whole-egg pulp generally leaves a residue of 5 to 6% of the original fermentable sugar (by *S. cerevisiae*). Thus, while resting-cell yeast fermentation removes close to 98% of the reducing value of whole-egg pulp as measured by the Somogyi method *(17)*, the enzyme process removed only 92 to 93%. This difference is illustrated in Figure 1 for separated egg white and yolk as well as whole-egg pulp. Since the

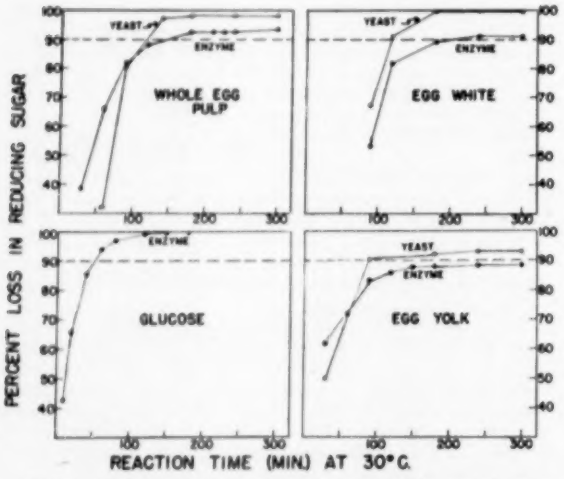


Figure 1. Incomplete removal of fermentable sugars from egg liquids by glucose oxidase. Reaction conditions were approximately those described under "Experimental." Ordinate values calculated from the percent reduction in the original Somogyi reducing value.

enzyme removes pure glucose to the extent of 99.5% or more (Figure 1), there is some evidence for the presence of free reducing sugars other than glucose in eggs, an observation, which, so far as we know, has not been made previously.

[b] By Leonard MacDonnell, this Laboratory.

These residual sugars were investigated in a single experiment as follows: Whole egg pulp "desugared" by the enzyme method was deproteinated by precipitation with $Zn(OH_2)$ according to the technique used in the Somogyi method. The protein-free filtrate was desalted by passage through columns of Dowex 50 and Permutit S and then was chromatographed on filter paper with butanol-ethanol-water (10:1:2) used for development. The chromatogram when sprayed with a solution of 3,5-dinitrosalicylic acid showed three reactive spots, none of which corresponded to glucose. Two of the components represented by spots had migrated at the same rates as galactose and mannose, respectively, and were presumably those compounds. The third was less well defined and represented a slower moving and apparently trace component.

Since neither fructose nor glucose was detected on the chromatogram, we were able to determine the amount of mannose in the protein-free and salt-free filtrate on a separate aliquot according to the technique described by Winzler *(20)*, in which the carbon dioxide produced by resting yeast cells in the presence of added sodium azide is measured. In the present case, *Torulopsis monosa*, a yeast which ferments only glucose, fructose, and mannose, was used *(13)*. By this technique, 2.8 to 2.9% of the original fermentable reducing sugar was judged to be mannose. By difference it is concluded that the remaining 2 to 3% of fermentable sugar is chiefly galactose. These identifications should, of course, be considered tentative in the absence of more conclusive and confirmatory data. However, both the chromatographic identification of galactose and mannose and the demonstration of the fermentability of at least half of the residual sugar by *T. monosa* have been repeated in separate preparations from different samples of enzymatically desugared whole egg. Although galactose is not considered to be fermentable by *S. cerevisiae*, Spiegelman *et al. (18)* have shown that adaptation does occur slowly under anaerobic conditions and the rate of adaptation is greatly accelerated by the presence of glucose, which of course is present in considerable excess of the other free sugars in egg pulp.

Since reducing sugars other than glucose remain after the glucose-oxidase desugaring procedure, the enzyme activity is obviously highly specific. An effort was made to appraise this specificity in a more quantitative manner. This was done manometrically on a single commercial enzyme solution preparation of Deoxygenase (Takamine Laboratories) as shown in Figure 2. The results are in general agreement with the previous findings of Keilin and Hartree *(8)*, who, working with an electrophoretically and ultracentrifugally homogeneous, purified glucose-oxidase preparation, found that the activity of their preparation on mannose and galactose was approximately 0.28 and 0.19%, respectively, of the corresponding activity on glucose.

Examination of initial quality of enzyme-desugared whole-egg powders. By comparison with standard (no pretreatment) or yeast-desugared whole egg powders, the enzyme desugared product was found to exhibit slight but noticeable differences in performance.

Scrambled eggs obtained with commercially processed (pasteurized and spray-dried) enzyme-desugared whole egg powders were observed to have a slight grainy or mealy texture and a faint "wet-feather" odor. These characteristics resembled those previously observed in commercially prepared acidified (pH 5.5) powder *(12)* but in this case were exhibited to a much lesser extent. The same texture defect was not, however, noticeable in scrambled eggs obtained with laboratory-prepared (lyophilized) enzyme-desugared powders.

This observation on the altered performance of the enzyme product in scrambled eggs is qualitative and based chiefly on personal experiences of the authors; however, one experiment was performed which established the difference clearly. Standard, yeast-desugared and enzyme-desugared spray-dried powders and a lyophilized standard powder all prepared from the same batch of whole egg pulp were served as coded samples

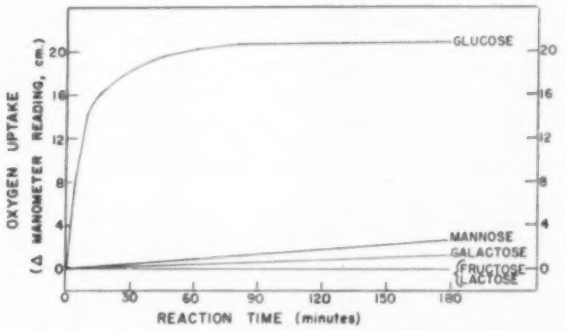


Figure 2. Some manometric measurements illustrating the specificity of the glucose oxidase in commercial "Deoxygenase." Reaction at 30° C. in O_2 atmosphere. Per Warburg vessel: 0.5 ml. of solution containing 5 mg. sugar; 0.1 ml. M/1 acetate, pH 5; 0.15 ml. Deoxygenase solution; water to 1.5 ml.

to a trained panel according to a balanced incomplete block design, which permitted occasional duplication within a single block. The judges were asked to indicate samples in each block that were alike in flavor and texture. That the scrambled eggs prepared from the enzyme-desugared powder were distinctly different from those prepared with the other powders was shown by the following results. In no case did the judges pair the enzyme powder with one of the other three and at the same time they detected the duplication of enzyme samples within a single block with an accuracy of 85%. On the other hand the judges were not able to discriminate between the other 3 samples and they paired them with each other in a randomized fashion.

In sponge-cake performance, the enzyme-desugared powders also showed some evidence of alteration. The volumes obtained were slightly lower than those of cakes made with comparably prepared standard (untreated) or yeast-desugared whole-egg powders. This effect was observed for both lyophilized and commercially processed powders (Figure 3).

These observations led us to investigate the possibility that some damage to the product was inherent in the enzyme process, and it seemed logical to suspect either oxidative action by the hydrogen peroxide or

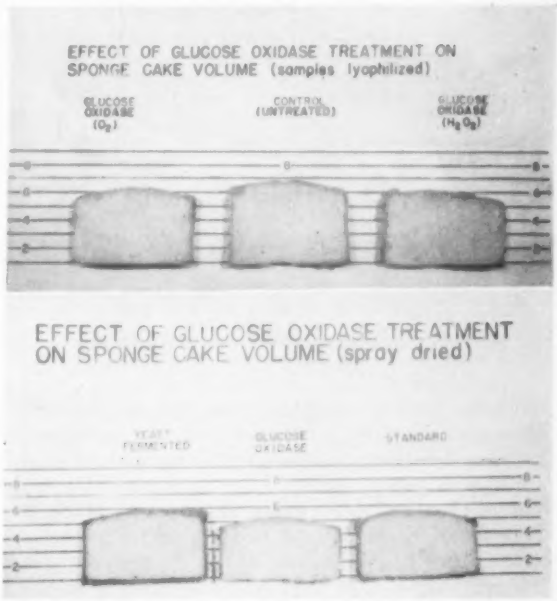

EFFECT OF GLUCOSE OXIDASE TREATMENT ON SPONGE CAKE VOLUME (samples lyophilized)
GLUCOSE OXIDASE (O_2)
CONTROL (UNTREATED)
GLUCOSE OXIDASE (H_2O_2)
EFFECT OF GLUCOSE OXIDASE TREATMENT ON SPONGE CAKE VOLUME (spray dried)
YEAST FERMENTED
GLUCOSE OXIDASE
STANDARD

Figure 3. Decreased sponge cake volumes from enzyme-desugared whole egg powders. Standard and untreated control powders both refer to samples dried without pretreatment.

protein denaturation from foaming that accompanied the decomposition of the hydrogen peroxide. Enzyme-desugared whole egg powders were therefore examined for evidence of such changes.

As shown in Table 1 and Figure 4, no evidence for either oxidative change or protein denaturation could be obtained. Thus, sites which are known to be labile to

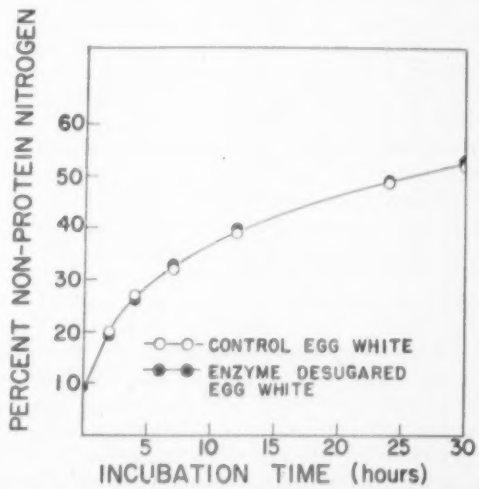


Figure 4. Rate of digestion of untreated and enzyme-desugared lyophilized egg whites by crystalline alpha-chymotrypsin. Reaction mixture held at 30° C. with approximately 1% added toluene and chloroform. Mixture contained 1 g. lyophilized white and 50 mg. chymotrypsin dissolved in 100 ml. of water buffered at pH 7.9. For soluble nitrogen determination, 15 ml. of reaction mixture plus 5 ml. of 10% trichloroacetic acid held at 70° C. for 5 minutes, centrifuged and microkjeldahl assay run on clear supernatant. Zero time soluble nitrogen value is probably ovomucoid which is not precipitable under the above conditions.

TABLE 1

Evidence of lack of oxidation or protein denaturation in enzyme desugared whole-egg powders

Preparation	Protein solubility, %	Soluble NH_2-N, % of powder	Sulfhydryl groups,[1] meq-SH/g.		Peroxide value, meq/kg.	Cartenoids, μg./g. of powder	Ether soluble fluorescence, ϕ	Absorbancy of ether extract at 268 mμ
			Native	Denatured				
Lyophilized powders								
(1) Control [2]	96	....	.182	.275	0	48	....	.93
(2) Enzyme-desugared	95	....	.185	.286	0	48	....	.93
Spray-dried powders—Plant A								
(1) Control	88	.35	....	....	0	90	0.9	1.22
(2) Enzyme-desugared	93	.36	.182	.286	0	91	0.8	1.21
(3) Yeast-desugared	94	.38	.184	.283	0	90	0.8	1.24
Spray-dried powders—Plant B								
(1) Enzyme-desugared	94	.42	.171	.273	0	....	1.4	....
(2) Yeast-desugared	94	.43	.172	.274	0	....	1.7	....

[1] Meq-SH per gram of ether-extraction residue. Guanidine hydrochloride used for denaturation.
[2] Control samples were powders prepared without pretreatment.

oxidation were found to be unaffected, as was evident from unchanged total carotenoid content, no peroxide formation in the total lipid, and no loss of protein sulfhydryl group activity. Increases in ether-soluble fluorescence and ultra-violet absorbancy, which have been found in this laboratory to be useful measures of autoxidizing egg phospholipid, also did not occur. Lack of significant change in either total nitrogen soluble in 10% KCl (reported as protein solubility since approximately 96% of this nitrogen is derived from the protein components), or in amino-N soluble in 10% KCl, indicated that the enzyme process also did not cause measurable protein denaturation. Additional evidence along these lines was provided by the fact that the "native" or reactive sulfhydryl groups were not increased by the enzyme process. Similar results, not shown in the table, have been obtained in sulfhydryl-group analyses of enzyme-desugared egg white.

Another property which was examined as an index of protein denaturation was the rate of proteolytic digestion. For convenience this was appraised with crystalline α-chymotrypsin and enzyme-desugared egg white. As shown in Figure 4, no increase in digestion rate resulted from the application of enzyme desugaring.

Since no specific oxidative or deleterious effects of a physical nature could be established as resulting from application of the enzyme desugaring method, a closer examination was made of the influence of the pH change *per se* associated with the process. Reconstituted enzyme-desugared whole egg has a pH of 6.9 to 7.2 in contrast to a pH range of 8.5 to 9.0 for standard or yeast-desugared whole egg powders, the lower pH in the former case resulting, of course, from the conversion of glucose to gluconic acid. The evidence obtained does strongly suggest that the behavior of enzyme-desugared powder can be approximated by the simple addition of acid in an amount equivalent to that produced by the process. Thus, as shown in Figure 5, adding such an equivalent amount of either gluconic or hydrochloric acid to whole egg pulp and lyophilizing, yield powders which show the typically lowered sponge cake volume (compare with Figure 3). In the preparation of these cakes the batter pH obtained with the enzyme-desugared or acidified powders was 5.6 in contrast to 6.6 for control powders. Any effect on sponge-cake volume was unexpected, however, since a batter pH of 5.6 is in the range generally used *(9)* and further, it has been previously reported that varying the batter pH in the range of 5.6 to 6.6 has no influence on sponge-cake volume *(7)*.

It was also found that the granular texture observed in scrambled eggs prepared from commercially processed enzyme-desugared powder could be closely duplicated with powders having an equivalent acidification before drying. Thus, yeast-desugared powder adjusted with acid before drying to yield a pH close to 7 in the reconstituted dry product and processed in commercial equipment also exhibited both granular scrambled-egg texture

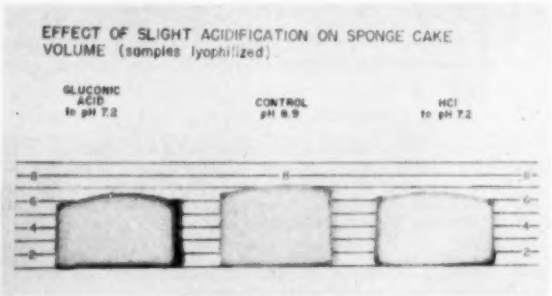

EFFECT OF SLIGHT ACIDIFICATION ON SPONGE CAKE VOLUME (samples lyophilized)
GLUCONIC ACID to pH 7.2
CONTROL pH 8.9
HCl to pH 7.2

Figure 5. Decreased sponge cake volumes resulting from addition of acid in an amount equivalent to that produced by the enzyme process.

and decreased sponge-cake volume. This is perhaps best exemplified by results of a study made primarily to compare initial consumer acceptability of enzyme- and yeast-desugared whole egg powders. Yeast-desugared powder having a reconstituted pH of 6.9, enzyme-desugared powder of pH 7.1, and standard (unacidified) yeast-desugared powder of pH 8.6 were prepared under closely identical conditions in a commercial plant from the same batch of whole egg pulp. The 3 powders prepared as scrambled eggs were compared before storage by the paired preference test. As shown in Table 2, in none of the pairs was a statistically significant preference obtained. However, the results suggested a similarity in performance of the pH 7 yeast-desugared powder and the enzyme-desugared powder of comparable pH. Thus, when these 2 powders were paired a larger number of individuals could not distinguish between them (stated no preference) than was the case with the other 2 pairs. Similarly the two pH 7 powders fared approximately the same in their respec-

TABLE 2

Paired preference consumer-type appraisal before storage of three types[1] of whole-egg powder (spray-dried) judged as scrambled eggs

	A			B			C		
	Y9	Y7	No preference	Y9	D	No preference	D	Y7	No preference
Preference judgments by groups of 40 individuals	19	14	7	19	15	6	11	15	14
Preference, allocated total basis,[2] %	56	44	...	55	45	...	45	55	...

[1] Y9 = unacidified yeast desugared powder, pH 8.6.
Y7 = acidified yeast desugared powder, pH 6.9.
D = glucose oxidase desugared powder, pH 7.1.

[2] "No preference" judgings were divided equally between each member of a pair to obtain allocated totals. A 67.5% preference is required for significance at the 5% level.

tive paired comparisons with the pH 9 yeast powder. Of course, the principal conclusion drawn from the limited data shown in Table 2 was that the texture aberrations qualitatively noted in both the enzyme-desugared and acidified yeast-desugared powders did not significantly affect their consumer acceptability.

Relative stability of the two powders. The small amount of residual reducing sugar present in enzyme-desugared powder does not appear to noticeably affect its stability. This is evident in the comparison of the relative effectiveness of the enzyme and yeast methods in minimizing the extensive changes occurring during storage in standard (no pretreatment) powder. Table 3 shows such a comparison of the 3 powders prepared from the same egg pulp and stored at 100° F. (37.7° C.) in N_2. These powders had a moisture content of 3.5 ± 0.1%. The two desugaring methods appear to be nearly equally effective in reducing the extent of storage changes as measured by chemical and physical methods or sponge-cake performance. Examination of the cakes also illustrates the elimination of browning by the two desugaring methods (Figure 6).

In this particular experiment the striking improvement in flavor stability resulting from enzyme desugaring was readily apparent (Table 3) but such was not the case for the comparably prepared yeast-desugared

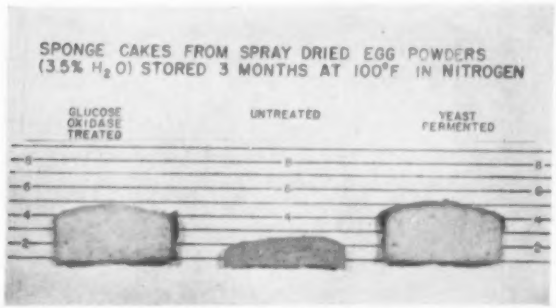

SPONGE CAKES FROM SPRAY DRIED EGG POWDERS
(3.5% H_2O) STORED 3 MONTHS AT 100°F IN NITROGEN
GLUCOSE OXIDASE TREATED
UNTREATED
YEAST FERMENTED

Figure 6. Sponge cake comparison illustrating the approximately equivalent stabilization against browning and volume loss effected by the two desugaring methods.

powder. Whereas this latter powder possessed excellent initial palatability, an atypical off-flavor, most frequently described as a mustiness, developed during storage. This caused such a varying response from the trained panel that the results could not be handled very well statistically. For that reason the average taste score of the yeast-desugared powder in this study is not recorded in Table 3. Since this mustiness did not develop in the enzyme-desugared powders prepared from the same egg pulp, it would appear to represent a problem associated with the yeast process. It has been observed by us only during storage of high-moisture (3.5% or greater) yeast-desugared powder prepared from egg pulp of poor sanitary quality. The egg pulp used in the study where this trouble developed was obtained by thawing frozen "summer" egg and had a standard plate count of 20 x 10^5 and a coliform count of 9 x 10^5 *(2)* before processing.

TABLE 3

Relative stabilities of untreated, enzyme- and yeast-desugared powders (3.5% water) at 100° F. in nitrogen

Analysis	Time (mo.) at 100° F.	Untreated	Enzyme	Yeast
Glucose, % of whole powder	0	0.91	0.09	0.02
	2	0.10	0.01	...
Salt-water-soluble fluorescence (ϕ)	0	1.4	1.2	1.3
	2	18.0	4.2	3.6
Protein solubility, (%)	0	90	93	93
	2	62	87	89
Soluble amino-N (% of whole powder)	0	0.37	0.35	0.37
	2	0.23	0.33	0.34
Volatile acids (mg. as acetic per g.)	0	0.20	0.26	0.54
	2	0.93	0.38	0.58
Lipid fluorescence, (ϕ)	0	0.9	0.8	0.8
	2	22.0	5.5	5.2
Lipid u.v. absorbancy (310 mμ)	0	0.24	0.23	0.24
	2	0.78	0.30	0.27
Sponge cakes (volume, ml.)	0	517	486	554
	3	189	467	472
Scrambled eggs (taste score)[1]	0	9.7	9.7	9.8
	1	3.8	8.4	...

[1] 10 = no storage off-flavor.
0 = extreme storage off-flavor.
Difference required for significance at the 5% level = 1.2.

In another experiment in which the enzyme- and yeast-desugared powders were prepared in a commercial plant under more favorable conditions, i.e., from current-receipt eggs of high candled grade (standard plate count of pulp 3.5 x 10^5, coliform count 1.8 x 10^5), this mustiness did not develop during the storage of the yeast-desugared powder and a direct comparison of the flavor stability achieved by the two desugaring methods was therefore possible. Three powders were prepared, all from the same parent egg pulp, as follows: a yeast-desugared powder with a reconstituted pH of 8.6, a slightly acidified yeast-desugared powder of pH 6.9 and an enzyme-desugared powder of pH 7.1. The powders had a moisture content of 3.7 ± 0.1%. Flavor stability was appraised both by trained taste-panel

method, which measures only degree of change from the control powder, and by consumer-type paired preference test which, of course, takes the total off-flavor into consideration. The trained-panel results (Table 4) indicated that rates of storage off-flavor development were equivalent for the 3 powders stored under N_2 for one and 2 months at 100° F. The consumer-type test (Table 5) after one month of storage at 100° F. showed very little change from the results obtained before storage (cf. Table 2) and again failed to show a significant preference in any of the 3 pairs. Thus the 2 methods of evaluating comparative flavor stability appeared to be confirmatory. It might be worth while to note that although a significant preference was not obtained for any powder either before or after storage, a numerical preference for the pH 8.6 yeast-desugared powder over the two pH 7 powders was consistently observed.

TABLE 4

Relative flavor stability of enzyme- and yeast-desugared powders (3.7% H_2O) at 100° F. in N_2 as appraised in scrambled eggs by a trained taste panel

Sample	Trained panel score [1,2] storage time at 100° F.	
	1 mo.	2 mo.
Control (enzyme-desugared, kept at —20° F. in N_2)	9.1	9.1
Enzyme-desugared, pH 7.1	6.9	5.6
Yeast-desugared, pH 6.9	6.4	5.4
Yeast-desugared, pH 8.6	7.2	5.3

[1] 10 = no storage off-flavor.
0 = extreme storage off-flavor.
Labelled controls; yeast-desugared pH 8.6 and enzyme-desugared pH 7.1 served with each block of coded samples.

[2] Samples removed after 1 month's storage at 100° F. were placed at —30° F. so that they could be appraised simultaneously in a balanced incomplete block design with those samples removed after 2 months at 100° F. Differences required for significance at the 5% level = 1.1.

Because the mustiness mentioned above appeared in the one experiment in which flavor comparison of air-packed samples was attempted, comparative data on air-packed samples were not obtained. However, some objective measurements suggest that oxidative deteriorations in the 2 types of desugared powders are also probably comparable. For example, the labile carotenoids appeared to disappear at the same rate in both powders (Table 6). Oxygen uptake by the 2 glucose-free powders occurred at approximately the same rate as shown in Figure 7. This figure also again illustrates the effect of glucose removal *per se* on reducing oxygen uptake, a phenomenon which we have previously attributed to the elimination of the glucose-cephalin interaction product which is bleached upon exposure to air *(11)*. Peroxide development in the lipid constituents could not be detected in any of the powders described in this report.

Previously it has been shown that glucose-free powders are still subject to important chemical and flavor changes when stored either under conditions of exposure to air or above a 2% moisture content *(11)*. Despite occasional reports to the contrary *(16)*, glucose-free

TABLE 6

Stability of carotenoids in untreated and glucose-free whole-egg powders (3.5% H_2O) [1]

Sample	Carotenoids, μg./g. of powder storage	
	2 mo. at 100° F.	4 mo. at 70° F.
Untreated control (—20° F. in N_2)	91	89
Untreated, stored in N_2	88	88
Untreated, stored in air	74	76
Enzyme-desugared control	91	92
Enzyme-desugared, stored in N_2	90	92
Enzyme-desugared, stored in air	74	81
Yeast-desugared control	90	89
Yeast-desugared, stored in N_2	88	89
Yeast-desugared, stored in air	67	77

[1] Stored in No. 2½ cans (401 x 411), 350 g. of egg powder per can.

powders prepared by the enzyme method do not differ from yeast-desugared powders in being immune to such changes. To illustrate this point the effect of air storage on the flavor stability of enzyme-desugared whole egg powder is shown in Table 7.

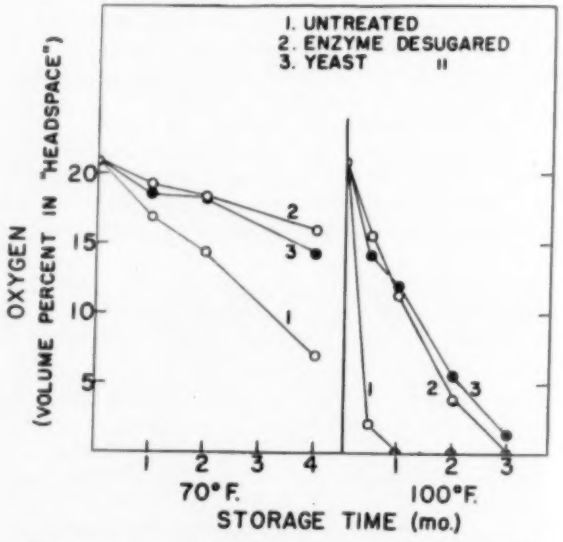


Figure 7. Comparative rates of oxygen uptake by untreated, yeast-desugared and enzyme-desugared whole egg powders (3.5% H_2O) stored in No. 2½ cans containing 350 g. of powder per can.

TABLE 5

Paired preference consumer-type appraisal of yeast- and enzyme-desugared whole-egg powders after storage for 1 month at 100° F. in N_2 [1]

	A			B			C		
	Y9	Y7	No preference	Y9	D	No preference	D	Y7	No preference
Preference judgments by groups of 40 individuals	22	15	3	20	13	7	19	13	8
Preference, allocated total basis,[2] %	59	41	—	59	41	—	57	43	—

[1] Cf. Table 2 for description of powders and comparisons before storage.

[2] A 67.5% preference is required for significance at the 5% level.

TABLE 7

Effect of storage in air on flavor stability of untreated and enzyme-desugared powders (3.5% H_2O)[1]

Sample	Trained taste panel scores	
	1 mo. at 100° F.[2]	4 mo. at 70° F.[3]
Control (enzyme-desugared powder kept at 20° F. in N_2)	9.7	9.7
Untreated, stored in N_2	3.8	7.7
Untreated, stored in air	2.7	6.7
Enzyme-desugared, stored in N_2	8.4	8.8
Enzyme-desugared, stored in air	5.4	7.3

[1] Stored in No. 2½ cans (401 x 411), 350 g. of egg powder per can.
[2] Difference required for significance at the 5% level = 1.2.
[3] Difference required for significance at the 5% level = 1.0.

SUMMARY AND CONCLUSIONS

The use of glucose oxidase for desugaring whole-egg liquid leaves a residue of 5 to 6% of the original fermentable reducing sugar which, according to the evidence presented, appears to consist chiefly of mannose and galactose. Evaluations show, however, that this small amount does not significantly impair stability.

In performance, the enzyme-desugared powders exhibit some slight differences from standard or yeast-desugared powders, such as graininess in scrambled eggs and slightly lower sponge-cake volumes. The possibility that these differences arise from either oxidative damage or protein denaturation was discounted by a number of negative analyses. Evidence obtained strongly suggests that the differences resulted almost entirely from the pH change inherent in the process. Thus lyophilized eggs which had an amount of either gluconic or hydrochloric acid added equivalent to that produced by the enzyme process, or commercially prepared yeast-desugared eggs, adjusted before drying to yield a pH in the final powder comparable to that in enzyme-desugared powder, exhibited the typical behavior of the enzyme-desugared product.

Consumer-type preference tests indicated, at least as far as scrambled eggs are concerned, that the slight graininess mentioned above did not significantly affect the consumer acceptability of either the enzyme-desugared powder or the yeast-desugared powder with equivalent acidification.

Stability comparisons of glucose-free powders prepared by the two desugaring methods indicated that equivalent stabilization was achieved as appraised by chemical, functional, and flavor tests. Although most of the storage studies were conducted under nitrogen pack, limited comparisons under air pack also indicated that the two desugaring methods were again equivalent and discounted the possibility that use of the enzyme method and its attendant oxidative conditions during processing would accelerate oxidative deterioration of the resulting powder.

A special problem associated with the yeast process appears to be the occasional development of mustiness on storage. In one experiment where yeast- and enzyme-desugared powders were prepared from the same parent egg pulp, this atypical odor and flavor developed on storage only in the yeast-desugared powder. The explanation for this phenomenon is obscure.

Acknowledgment

We are indebted to Agnes Campbell, Joan E. Gegg, Kazuko Nishita, and Mary B. Wiele for general technical assistance throughout the course of the work and to Rolland M. McCready for the chromatographic analyses.

LITERATURE CITED

1. Association of Official Agricultural Chemists. *Official and Tentative Methods of Analysis*, 6th ed. (1945).
2. American Public Health Association. *Standard Methods for the Examination of Dairy Products*, 9th ed. (1948).
3. Coulthard, C. E., Michaelis, R., Short, W. F., Sykes, G., Skrimshire, G. E. H., Standfast, A. F. B., Birkinshaw, J. H., and Raistrick, H. Notation: an antibacterial glucose-aerodehydrogenase from *Penicillium notatum* Westling and *Penicillium resticulosum* sp. nov. *Biochem. J.*, **39**, 24 (1945).
4. Dutton, H. J., and Edwards, B. G. Determination of carotenoids and lipid aminoaldehyde products in dehydrated egg. *Ind. Eng. Chem.*, **38**, 38 (1946).
5. Hanson, H. L., and Kline, L. Consumer-type appraisal of whole egg powder stabilized by glucose removal and by acidification. (In press.)
6. Hanson, H. L., Kline, L., and Lineweaver, H. Application of balanced incomplete block design to scoring of ten dried egg samples. *Food Technol.*, **5**, 9 (1951).
7. Jordan, R., and Pettijohn, M. S. Use of spray-dried whole-egg powder in sponge cakes. *Cereal Chem.*, **23**, 265 (1946).
8. Keilin, D., and Hartree, E. F. Properties of glucose oxidase (notatin). *Biochem. J.*, **42**, 221 (1948).
9. King, F. B., Morris, H. P., and Whiteman, E. F. Some methods and apparatus used in measuring the quality of eggs for cake making. *Cereal Chem.*, **13**, 37 (1936).
10. Kline, L., and Sonoda, T. T. Role of glucose in the storage deterioration of whole egg powder. I. Removal of glucose from whole egg melange by yeast fermentation before drying. *Food Technol.*, **5**, 90 (1951).
11. Kline, L., Hanson, H. L., Sonoda, T. T., Gegg, J. E., Feeney, R. E., and Lineweaver, H. Role of glucose in the storage deterioration of whole-egg powder. III. Effect of glucose removal before drying on organoleptic, baking and chemical changes. *Food Technol.*, **5**, 323 (1951).
12. Kline, L., Sonoda, T. T., Hanson, H. L., and Mitchell, J. H., Jr. Relative chemical, functional, and organoleptic stabilities of acidified and glucose-free whole egg powders. *Food Technol.*, **7**, 456 (1953).
13. Kluyver, A. J. "Biochemische Suikerbepalingen." (Dissertation, Technische Hoogeschool, Delft, 1914.)
14. MacDonnell, L. R., Silva, R. B., and Feeney, R. E. The sulfhydryl groups of ovalbumin. *Arch. Biochem.*, **32**, 288 (1951).
15. Peryam, D. R., and Swartz, V. W. Methodology for sensory evaluation of imitation peppers. *Food Technol.*, **5**, 207 (1951).
16. Snyder, E. G. New enzymes "open new doors." *Food Eng.*, **25**, 89 (1953).
17. Somogyi, M. Determination of blood sugar. *J. Biol. Chem.*, **160**, 69 (1945).
18. Spiegelman, S., Reiner, J. M., and Cohnberg, R. The relation of enzymatic adaptation to the metabolism of endogenous and exogenous substrates. *J. Gen. Physiol.*, **31**, 27 (1947).
19. Wheeler, D. H. Peroxide formation as a measure of autoxidative deterioration. *Oil and Soap*, **9**, 89 (1932).
20. Winzler, R. J. Azide inhibition of anaerobic assimilation of glucose by yeast and its application to the determination of fermentable sugar. *Science*, **99**, 327 (1944).

Concentration of Strawberry Juice

L. H. WALKER, G. H. NOTTER, R. M. McCREADY, AND D. C. PATTERSON
Western Utilization Research Branch, Agricultural Research Service, United States Department of Agriculture, Albany 6, California

(Manuscript received March 23, 1954)

Methods are presented for the preparation of concentrated strawberry juice and for the recovery of volatile flavor constituents. Causes of gelation in juice, clarification by use of pectic enzymes, effect of varying percentages of evaporation during essence recovery, and effect of temperatures during concentration were determined.

Approximately 10% of the sound strawberries delivered to packing houses are unsuitable for use in fresh and frozen packs because of their size, shape, or minor blemishes. These factors affect the appearance of the pack but not the quality of such byproducts as strawberry juice, in which appearance of the berry, other than color, is not important.

Although some packers convert such berries into frozen juice and market it among jelly manufacturers, several factors have militated against full use of cull berries for this purpose. Costs involved in storage and shipment of strawberry solids in juice form, with its high percentage of water, are excessive. Variation in soluble solids content (from 5 to 10%) results in variable costs for different lots of juice and creates complexities in jelly formulation. Some lots tend to form more or less permanent gels during storage. The gels in certain lots disperse with relative ease, but in others, nondispersible gels develop and cause marked cloudiness in the jelly. The usual single-strength frozen juice is semi-opalescent, requires filtration, and does not produce a truly clear jelly.

This paper reports new processing techniques and outlines a method by which improved juice can be converted into a concentrate containing recovered volatile flavors. The investigations were undertaken in cooperation with Driscoll Strawberries, Inc., of San Martin, California. Studies of the causes of gelation have resulted in a method for elimination of pectic substances responsible for gelling and production of a clear, stable juice. Studies of essence recovery and juice concentration have resulted in a method for concentration to as high as 73° Brix (12-to-1 by volume). Both laboratory and commercially prepared concentrates have excellent quality. The flavor and color of the reconstituted product are comparable to those of the starting juice. The product is sparkling clear, shows no tendency to gel, and has been used to produce jellies of brilliant clarity. Products prepared commercially by these procedures have found ready acceptance.

CAUSES OF GELATION IN JUICE

The chief problem with single-strength juice was to find an explanation for the tendency of certain lots to gel. The fact that gels form in juices containing as little as 5% to 6% soluble solids is surprising, since most fruit juices require concentration to at least 40% soluble solids before gelling occurs.

In the studies on causes of gelation, the tendency of various lots to gel was measured by holding samples at 50° F. and observing gel formation over a period of 28 days. The presence of the pectin-demethoxylating enzyme, pectinesterase, which is found in most fresh fruits, was established and its activity was measured by the method of MacDonnell, Jansen, and Lineweaver *(3)*. Total pectins as measured by anhydrouronic acid content were determined by the method of McComb and McCready *(4)* and characterized by the procedures described by Owens *et al. (6)* after isolation by precipitation with 70% ethanol and partial purification.

Except for methoxyl content of the pectins, no consistent differences were noted among 13 samples examined. The calcium content was approximately the same at 0.015%. The pectinesterase activity was about 0.002 $[PEu]_{ml.}$ (milliequivalents of ester bonds split, per minute, per ml. of juice) and that of the purees from which the juices were expressed, about 0.02 $[PEu]_{ml.}$ The higher activity in puree was expected, because pectinesterase is known to be associated with the insoluble cell-wall constituents and not readily extractable without addition of salt and adjustment of pH to 7.5 or above. Anhydrouronic acid content varied from 0.18 to 0.31%, but there was no correlation of a high pectin content with increasing rates of gelation of the juices.

A direct correlation was found between methoxyl content of the pectins (a measure of the degree of pectin esterification) and rate of gelling of the juices. Pectins from 9 lots of juice that gelled slowly at 50° F. (20 or more days) had methoxyl contents of about 9% while those from 4 lots that gelled rapidly (3 to 6 days) had methoxyl contents of 2 to 5%. In the examples listed in Table 1, pectins from juices that gelled slowly

TABLE 1
Correlation of time required for gelling of strawberry juice with degree of pectin esterification

Sample	Gelling time at 50° F. (10° C.) (days)	Anhydrouronic acid content, fresh basic (percent)	Degree of esterification of pectins (percent)
1	3	0.18	25
2	3	0.27	41
3	6	0.31	59
4	14	0.26	65
5	23	0.26	68

(4 and 5) showed a high degree of esterification (65 to 75%) and are comparable in this respect to those found in most fruit juices. Pectins from juices that gelled rapidly (1 and 2) showed a low degree of esterification (20-50%) and are comparable in nature to low-methoxyl pectins.

Gelation appears to be the result of de-esterification of pectins in the juice or puree by the naturally occurring strawberry pectinesterase, to produce low-methoxyl pectins. These react with calcium in the juice to form gels. Juices that gelled rapidly at 50° F. already contained low-methoxyl pectins, probably produced during storage of cull berries before processing, and only slight further de-esterification of the pectins was required for gelation. As the activity of the enzyme is known to increase rapidly with temperature, this series of reactions explained the observation that all lots of juice gelled after standing at room temperature for several days.

Gelation of strawberry juice can be prevented by destruction of one of the components of the reaction described above. Pectins can be destroyed by use of commercial pectic enzyme prepara-

tions or pectinesterace can be inactivated by flash heat treatment, i.e., holding the juice at 185° F. (85° C.) for 2 minutes. Of the alternatives, destruction of pectins is preferable because the risks of flavor impairment inherent in flash heat treatment are avoided and clarification of juice treated in this manner is much simpler.

PREPARATION OF JUICE

Cold, sound, cull berries were forced through a ¼-inch screen in a hammer mill. Filter aid was added to the chopped berries in amounts of 3 to 10% and the slurry was pressed immediately in a bag-type press. The filter aid requirement was governed by firmness of the berries and was added in sufficient quantity to produce a firm, dry cake in the press. The yield of cloudy juice was found to vary from 70 to 80%, depending on variety, maturity, and perhaps other factors.

Cloudy juice from the press was treated immediately with a pectic enzyme preparation in order to remove the pectin component in the gelling reaction. Treatment for 3 hours at 75° F. (24° C.) with 0.5% Pectinol [a] was found to degrade the pectic substances sufficiently to permit production of a clear, stable juice and to prevent gelling in the concentrated product. Juice was clarified in a pressure filter using pre-coated plates and an addition of 0.25% of filter aid to the juice.

ESSENCE RECOVERY

Vacuum concentration of strawberry juice resulted in removal of practically all volatile flavor constituents from the concentrate. Hence, it was necessary to recover these essences by a separate operation, the commonest of which consists of recovery of these flavors in an essence recovery unit prior to concentration.

The method used for essence recovery was based upon the process of Milleville and Eskew *(5)*. Juice was heated to approximately 220° F. (104.4° C.) in the preheating section and the desired percentage of juice vaporized in the evaporating section of a laboratory essence recovery unit. Vapors containing volatile flavors were concentrated in a fractionating column to about 1% of the volume of the original juice. Residue from the stripping operation (stripped juice) was cooled in a heat exchanger to 80° F. (26.7° C.) within about 8 seconds after the juice had entered the preheater.

The degree of evaporation needed for a relatively high degree of essence recovery was determined by experimental runs made under conditions that resulted in evaporation of 10, 20, and 30% of the entering juice. Analyses for total esters were made by an adaptation of the method of Thompson *(8)*. Averages of analyses from several runs showed that at 10% evaporation, 7 p.p.m. of total analyzable esters on a single-strength basis were recovered; at 20%, 10 p.p.m.; at 30%, 11 p.p.m. The juice used originally contained 15 p.p.m. of esters. Approximately 1 p.p.m. of esters was found in the still bottoms regardless of percentage of evaporation and the balance in the stripped juice. The material found in still bottoms was bitter in flavor and yeasty in odor. These data indicate that evaporation of about 20% of the juice should be sufficient in commercial essence recovery units of the conventional type.

CONCENTRATION

The maximum temperature at which evaporation could be carried out in batch-type concentration equipment without noticeable change in flavor was determined in a falling film evaporator *(9)*. Unstripped juice was concentrated 7-fold by volume at constant pressure and the products of concentration (concentrate, distillate, and "non-condensibles" from alcohol-CO_2 traps) were recombined. The evaporating period for each run was 2.5 ± 0.1 hours.

Samples were prepared at pressures equivalent to boiling points of water of 85°, 100°, 115°, and 130° F. (1.2, 1.9, 3.0, and 4.5 inches of mercury absolute, respectively) and submitted products not mentioned.
to an organoleptic panel of experienced judges. The effect of color upon judgments was eliminated by use of green lighting in the taste booths. Averages of the panel scores were as follows:

Standard	85° F.	100° F.	115° F.	130° F.
7.16	6.60	6.52	5.42	4.54

Analyses of variance *(7)* showed that highly significant differences ($P = .01$) existed between the standard (untreated juice) and those concentrated at either 115° or 130° F. Juice concentrated at 100° F. was significantly different in flavor ($P = 0.5$) from that concentrated at 115° F. and highly significantly different from that concentrated at 130° F. In regard to color, no change was noted in samples concentrated at 100° F. or below. Above this temperature, the red color became progressively deeper and tended to become brownish.

These results show that if strawberry juice is to be concentrated under time-temperature conditions similar to those used in the laboratory, temperatures of 100° F. (1.9 inches Hg) or lower should be used in order to avoid detectable changes in flavor and color. Later runs showed that depectinized strawberry juice could be concentrated at this temperature to 73° Brix (12 to 1 concentration of an 8° Brix juice) without either operational difficulties or observable changes in flavor or color.

COMMERCIAL APPLICATION OF THE METHOD

Production of seven-fold strawberry juice concentrate based upon the procedures outlined above was undertaken on a commercial scale in the spring of 1953. Essences were recovered at a juice feed rate of 500 gallons per hour in a steam-injection type of stripper *(1)*, operated to produce a net evaporation of 12% of the entering juice (computed after allowing for re-evaporation of injection steam). The quantity of injected steam amounted to 8% of the entering juice. Analyses of samples from production runs showed that the degree of recovery (10 p.p.m.) was equal to that obtained on similar juice by 20% evaporation in the conventional laboratory unit. Concentration was carried out in a natural circulation evaporator equipped with an external heat exchanger at an absolute pressure of 1.9 inches Hg. Concentrated juice and concentrated (100-fold) essence were packed separately for the convenience of customers. The processors involved report that no serious operational problems have been encountered and that the products have been enthusiastically received by their customers.

Further commercial considerations. Elimination of the problem of gelation through degradation of pectins results in the production of sparkling clear juice and concentrated products. The tendency to gel might be minimized or eliminated in other ways. The time allowed for enzymatic action could be shortened by rapid processing of berries culled from an inspection belt. The rate of enzymatic de-esterification might be lowered by processing at low temperature, or enzymes might be destroyed by heat. None of these suggested treatments results in the degradation of pectins, without which clarification to a sparkling juice by ordinary filtration procedures is most difficult.

The fresh flavor of strawberry juice seems to be more delicate than that of most fruits. Unpublished data obtained in this laboratory show that the flavor of freshly pressed juice or puree changes to a noticeable extent after a few hours at room temperature. This susceptibility suggests certain modifications in usual juicing

[a] Mention of this product is illustrative and does not constitute endorsement by the Department of Agriculture over other

procedures. Berries should be as cold as practicable when comminuted in a hammer mill. Puree should be pressed immediately and juice should be either frozen or treated with pectic enzymes as rapidly as possible. Likewise, delays after pectin degradation should be avoided. The same consideration is a limiting factor in determining time, temperature, and pectic enzyme concentration relationships required for pectic degradation. Hence, the usual methods for cutting down the required amount of pectic enzymes (lengthening of the period of treatment or increasing the temperature during treatment) may result in serious impairment of flavor in the product. In addition to protection of the natural strawberry flavor, rapid handling throughout the process will prevent the onset of fermentation, thereby holding the alcohol content of concentrated essence well below the maximum (6%) permitted by Federal regulations *(2)*.

The degree of evaporation planned in the stripping operation will affect both purchase price and operating cost of the essence recovery unit. The 20% that appears necessary in a conventional stripper is higher than that needed for production of apple essence, but should be worth the additional cost in enhanced product quality.

Recovered essences can be incorporated with the concentrate to make a full-flavored product or they can be packaged separately. The latter procedure may be advantageous, as the jelly manufacturer may wish to incorporate the essence with the completed jelly just prior to filling, thereby eliminating volatilization of a great deal of essence during heating of the ingredients.

Both concentrated juice and concentrated essence should be packed in enamel-lined containers and stored in the frozen condition, because the extent to which product deterioration and can corrosion may affect quality is unknown. Both concentrated essence and concentrated juice containing essence should be hermetically sealed, since a slight leak may result in drastic loss of flavor during prolonged storage. Concentrate free of essence can be packed in any liquid-tight, enameled container such as a screw-top can.

The degree of concentration applied depends to a large extent upon a balance between savings in freezing, storage and shipment, on the one hand, and costs of concentration on the other. The savings become less with each increment in concentration, while the cost increases at an accelerated rate owing to the falling off in rate of evaporation.

Equipment needed for concentration may be any of several types already proved to be suitable for fruit juice concentration. The upper limit of pressure (1.9 inches of mercury) mentioned above appears to allow a reasonable factor of safety against heat damage in equipment requiring an evaporating cycle of about 2.5 hours. Use of somewhat higher pressures may be allowable under conditions of very rapid concentration, but a decision to increase operating pressures above the recommended limit should be preceded by pilot runs.

There are other potential uses for the products prepared by this method. The concentrated juice can be used as the flavoring constituent for a natural-flavored strawberry sherbet. It can also be used to prepare a concentrated beverage of natural strawberry flavor and color by addition of sufficient sugar to offset the astringent flavor of unsweetened strawberry juice.

SUMMARY

Gelation of single-strength strawberry juice was shown to be due to de-esterification of pectins.

Conditions have been determined for the treatment of strawberry juice with a pectic enzyme preparation, sufficiently to permit clarification to a sparking juice and production of an equally clear, nongelling concentrate.

A process has been developed for producing a clear, depectinized strawberry juice concentrate of up to 12-fold concentration by volume.

A method has been developed whereby volatile flavor constituents can be recovered, either for incorporation with the concentrate or with manufactured strawberry jelly. The economic degree of evaporation during stripping in conventional equipment consistent with adequate ester recovery appears to be in the neighborhood of 20%.

The maximum allowable temperature during batchwise concentration in a laboratory falling-film evaporator was found to be 100° F. (1.9 inches of mercury).

LITERATURE CITED

1. Brown, A. H., Lazar, M. E., Wasserman, T., Smith, G. S., and Cole, M. W. Rapid heat processing of fluid foods by steam injection. *Ind. Eng. Chem.*, **43**, 2949 (1951).
2. *Federal Register* (published by U. S. National Archives). Volatile fruit-flavor concentrates, Vol. 14 (186), 5869 (Sept. 27, 1949).
3. MacDonnell, L. R., Jansen, E. F., and Lineweaver, Hans. The properties of orange pectinesterase. *Arch. Biochem.*, **6**, 389 (1945).
4. McComb, E. A., and McCready, R. M. Colorimetric determination of pectic substances. *Anal. Chem.*, **24**, 1630 (1952).
5. Milleville, H. P., and Eskew, R. K. Recovery and utilization of natural apple flavors. *AIC-63* (mimeographed). Eastern Regional Research Laboratory, Philadelphia 18, Pa., U.S.D.A. (April, 1944). Two-page supplement (1945).
6. Owens, H. S., McCready, R. M., Shepherd, A. D., Schultz, T. H., Pippen, E. L., Swenson, H. A., Miers, J. C., Erlandsen, R. F., and Maclay, W. D. Methods used at Western Regional Research Laboratory for extraction and analysis of pectic materials. *AIC-340* (mimeographed). Western Regional Research Laboratory, Albany 6, Calif., U.S.D.A. (June, 1952).
7. Snedecor, G. W. *Statistical Methods*, 4th ed., 1946. Iowa State College Press, Ames, Iowa.
8. Thompson, A. R. A colorimetric method for the determination of esters. *Australian Jour. Scientific Res., Series A*, **3**, 128 (1950).
9. Walker, L. H., and Patterson, D. C. An experimental falling film evaporator for preparation of juice and puree concentrates at low temperature. *Ind. Eng. Chem.*, **43**, 534 (1951).

Hygroscopic Equilibria of Dry Beans

W. J. WESTON AND H. J. MORRIS

Western Utilization Research Branch, Agricultural Research Service, United States Department of Agriculture, Albany 6, California

(Manuscript received March 26, 1954)

Equilibrium moisture values are reported for seven varieties of beans stored at 25° C. in relative humidities in the range from 11 to 75%. Equilibrium moisture values were not obtained for the relative humidity range from 80 to 98% because of development of mold growth. The time required for mold growth to become visible together with the moisture contents at these times is given for these humidities. There were no significant varietal differences in equilibrium moisture values. Varietal differences were observed, however, in the rates of change in moisture contents when beans were stored at high humidities.

The keeping quality of dry beans during storage is greatly influenced by their moisture content. Since moisture content varies with the atmospheric humidity, it is desirable to know the equilibrium moisture contents for different varieties of dry beans stored at various relative humidities. Equilibrium moisture values for Michigan-grown Michelite beans have been published *(9)*. Results are presented here for six additional varieties as well as for Michelites grown in Idaho.

MATERIALS AND METHOD

The beans used were from the 1949 harvest. The Great Northern (University of Idaho No. 16), Idaho-grown Michelite, pinto (University of Idaho No. 78), and the Red Mexican (University of Idaho No. 3) varieties were furnished by the Idaho Agricultural Experiment Station. The dark red kidney and light red kidney varieties were the Calapproved quality obtained from the Stockton District Kidney Bean Growers Association, Linden, California. The flat small white variety was furnished by the Idaho Bean and Elevator Company, Troy, Idaho.

A detailed history of the beans during the interim of approximately two months between harvesting and arrival at the Laboratory is not known. However, since they were procured, with exception of the flat small white variety, in the late fall, when the weather was cool, it is unlikely that they had been subjected to any unfavorable storage condition. The flat small white variety was obtained about 2 months after the other varieties. On arrival at the Laboratory, all varieties were in excellent condition. With the exception of flat small whites, all were stored for 2 months at 25° C. and approximately 45% relative humidity prior to the experiment. Since no official method for determining moisture in beans is given by the A.O.A.C., the initial moisture contents of the beans were determined by the method of Makower *et al. (8)*. This method employs a vacuum of 3 mm. of mercury and a temperature of 70° C. for 40 hours. Moisture values by this method for beans which had been ground to 40-mesh did not differ significantly from the results obtained by the official method *(1)* for cereal foods. Samples of each variety were stored at 25° C. in relative humidities ranging from 11 to 98%. The desired humidities were obtained by storing the beans in desiccators containing the appropriate saturated salt solution in contact with excess solid salt. The solutions used for this purpose are described by Stokes and Robinson *(10)* and Wink and Sears *(12)*. In order to insure adequate ventilation, the beans were contained in cylindrical baskets (5.0 cm. in diameter and 11.5 cm. high) made from 8-mesh, stainless-steel-wire cloth.

One-hundred-gram samples of cleaned, selected beans with intact seed coats were used. Weighings were made periodically until the samples had reached constant weight, or in the case of those stored at relative humidities of 80.7% and above, until the onset of mold growth. The equilibrium moisture contents were calculated from the original moisture contents and the changes in weight of the samples. All results are expressed on a wet-weight basis.

RESULTS AND DISCUSSION

The rates of approach to moisture equilibrium at different relative humidities for Michelite beans are shown in Figure 1. These curves were selected as representative of the data obtained for the 7 varieties when stored at 11 relative humidities. As would be expected, the initial rates of change in moisture content were proportional to the difference between the moisture content of the sample and the moisture content at equilibrium. As equilibrium was approached, the rates of change decreased. At humidity levels high enough to permit mold growth, anomalous behaviors were encountered before equilibrium could be attained. Figure 2 represents graphically the relationship of equilibrium moisture content of Michelite beans to storage relative humidity at 25° C.

This type of curve is characteristic of many seed materials *(2, 5, 6)*. The effect of direction of approach

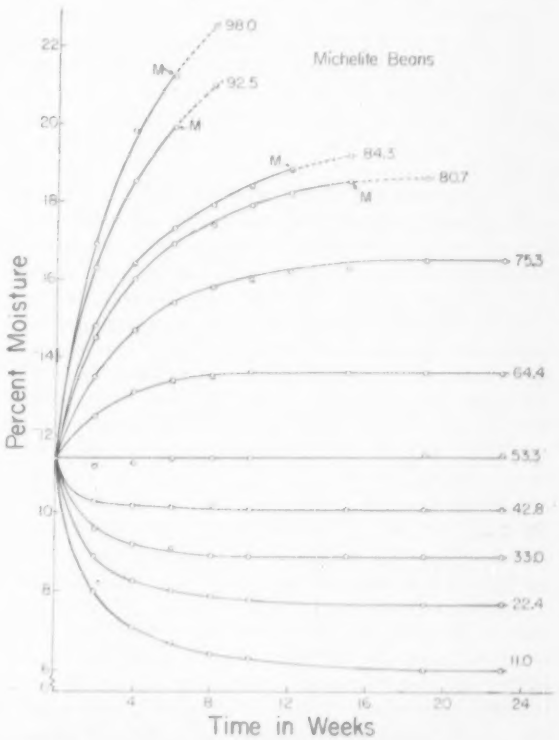


Figure 1. Rates of approach to moisture equilibrium for Michelite beans at 25° C. at various relative humidities. M indicates time at which mold became visible.

(i.e. absorption versus desorption) on the equilibrium moisture content for a given relative humidity was not studied. The equilibrium moisture contents for the Idaho-grown Michelites compare well with data published previously *(9)* for the Michigan-grown variety.

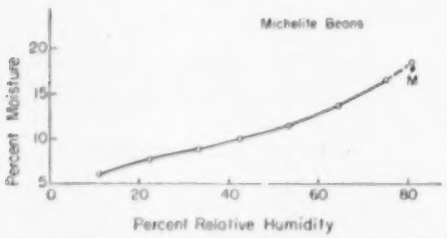


Figure 2. Relation of equilibrium moisture content of Michelite beans to storage relative humidity at 25° C. M indicates mold became visible.

The moisture contents at various humidities are summarized in Table 1.

Mold growth, determined visually without magnification, was first observed after 6 weeks' storage at a relative humidity of 98.0%, while at the 80.7% level it did not appear until the 11th week. Initially, the heaviest and often the only growth on the beans was limited to the micropyle or hilum areas. Since it is generally believed that aqueous tension, not actual moisture content, is the limiting factor for mold growth, the localized growth is probably due to the higher concentration of nutrients in these areas, since they are all subjected to the same aqueous tension. The same type of localized attack has been reported by Christensen, Olafsen, and Geddes *(3)* for cotton seed and by Wolf, Buzan, MacMasters and Rist *(13)* for the tip cap in corn. The time required for mold growth to become visible together with the moisture contents at these times is shown in Table 1.

For a particular relative humidity, the equilibrium moisture values for the different varieties were in excellent agreement. For most of the humidities studied, the values differed by only a few tenths of 1%. These very close agreements take on added significance since they were obtained for several varieties of beans grown in areas with different climatic conditions. Variations in any one variety grown in different years would likely be less than the variations in the different bean samples used in this study. However, varietal differences did appear in the rates of moisture uptake in the early phase of the storage period. The rates of the two strains of red kidney beans were significantly higher than those of the other varieties. This difference was quite apparent at the end of the second week, particularly with the samples stored in the higher humidities. This high rate of moisture absorption for kidney beans is surprising in view of the fact that they are larger than any of the other varieties and therefore contain a smaller number of micropyles and less surface area per 100 g. Obviously the rate of entrance of water through the micropyle or the skin (or both micropyle and skin) was considerably greater in the kidney beans.

The rates of change in moisture content obtained experimentally with controlled conditions would not of

TABLE 1

Rates of approach to moisture equilibrium, and final equilibrium values (last column), in beans stored at 25° C. in various relative humidities

Relative humidity	Moisture at various times (weeks)						
	2	4	6	8	10	19	23
Red Mexican (Initial moisture content 10.3%)							
%	%	%	%	%	%	%	%
11.0	8.2	7.2	6.8	6.6	6.5	6.2	6.1[1]
22.4	9.0	8.5	8.2	8.0	8.0	7.8	7.8
33.0	9.7	9.4	9.2	9.1	9.1	9.0	9.0
42.8	10.3	10.2	10.1	10.1	10.1	10.1	10.1
53.3	10.7	11.2	11.4	11.5	11.5	11.5	11.5
64.4	12.0	12.8	13.2	13.4	13.5	13.7	13.7
75.3	12.7	14.2	15.2	15.9	16.1	16.6	16.6
80.7	13.4	15.4	16.7	17.4	17.5	18.8[2] *(19)*	
84.3	13.4	15.7	17.2	18.0	18.5	19.3[2] *(15)*	
92.5	14.1	17.9	20.1	20.5[2] *(7)*			
98.0	15.5	19.6	21.3[2] *(6)*				
Great Northern (Initial moisture content 10.0%)							
%	%	%	%	%	%	%	%
11.0	8.9	7.0	6.6	6.4	6.3	6.2	6.0[3]
22.4	8.9	8.4	8.1	8.0	7.9	7.8	7.7[4]
33.0	9.5	9.2	9.0	9.0	8.9	8.7	8.7
42.8	10.1	10.0	10.0	10.0	10.0	10.0	10.0
53.3	10.8	11.1	11.2	11.2	11.3	11.3	11.3
64.4	11.9	12.6	13.0	13.3	13.4	13.5	13.5
75.3	12.8	14.2	15.1	15.7	15.9	16.4	16.4
80.7	13.4	15.3	16.7	17.4	17.8	18.1[2] *(12)*	
84.3	13.5	15.8	17.3	18.5	18.8[2] *(12)*		
92.5	14.2	17.8	20.0[2] *(6)*				
98.0	15.8	19.4	21.1[2] *(6)*				
Light Red Kidney (Initial moisture content 10.7%)							
%	%	%	%	%	%	%	%
11.0	8.0	7.3	6.9	6.7	6.5	6.2	6.2
22.4	9.1	8.5	8.2	8.0	8.0	7.8	7.8
33.0	9.7	9.4	9.2	9.2	9.2	9.1	9.1
42.8	10.4	10.3	10.3	10.3	10.3	10.3	10.3
53.3	11.3	11.5	11.6	11.6	11.6	11.6	11.6
64.4	12.8	13.3	13.6	13.6	13.7	13.8	13.8
75.3	14.1	15.2	15.7	16.0	16.2	16.6	16.6
80.7	15.0	16.4	17.2	17.8	18.1	18.7[2] *(15)*	
84.3	15.5	16.9	17.8	18.2	18.7	19.0[2] *(12)*	
92.5	16.9	18.8	20.5	21.5[2] *(8)*			
98.0	17.9	20.8	21.5				
Dark Red Kidney (Initial moisture content 9.3%)							
%	%	%	%	%	%	%	%
11.0	8.1	7.3	6.9	6.6	6.5	5.7	5.7
22.4	8.8	8.3	8.0	7.8	7.8	7.6	7.6
33.0	9.5	9.1	9.0	8.9	8.9	8.8	8.8
42.8	10.0	10.0	9.9	9.9	9.9	9.9	9.9
53.3	10.9	11.2	11.3	11.3	11.3	11.3	11.3
64.4	12.2	13.0	13.4	13.5	13.5	13.6	13.6
75.3	13.6	15.0	15.6	15.9	16.2	16.6	16.6
80.7	14.6	16.2	17.0	17.6	18.0	18.2[2] *(11)*	
84.3	14.9	16.6	17.5	18.1	18.4[2] *(9)*		
92.5	16.3	18.7	20.1[2] *(6)*				
98.0	17.5	20.2	21.4[2] *(6)*				
Flat Small White (Initial moisture content 13.0%)							
%	%	%	%	%	%	%	%
11.0	8.4	7.2	6.6	6.5	6.4	6.1	6.1
22.4	9.1	8.1	7.8	7.6	7.6	7.4	7.4
33.0	9.9	9.1	8.9	8.7	8.7	8.5	8.5
42.8	10.9	10.4	10.3	10.2	10.2	10.0	10.0
53.3	11.8	11.6	11.6	11.6	11.6	11.6	11.6
64.4	12.7	13.0	13.3	13.4	13.5	13.5	13.5
75.3	13.6	14.5	15.2	15.7	16.0	16.6	16.6
80.7	14.3	15.5	16.6	17.5	17.9	18.5[2] *(15)*	
84.3	14.5	16.0	17.2	18.1	18.6	19.6[2] *(15)*	
92.5	15.5	18.1	19.9	21.3[2] *(8)*			
98.0	16.7	19.9	21.2[2] *(6)*				
Michelite (Initial moisture content 11.4%)							
%	%	%	%	%	%	%	%
11.0	8.0	7.1	6.7	6.4	6.3	6.0	6.0
22.4	8.9	8.3	8.0	7.9	7.8	7.7	7.7
33.0	9.6	9.2	9.1	8.9	8.9	8.9	8.9
42.8	10.3	10.2	10.2	10.2	10.1	10.1	10.1
53.3	11.2	11.3	11.4	11.4	11.4	11.5	11.5
64.4	12.5	13.1	13.4	13.5	13.6	13.6	13.6
75.3	13.5	14.7	15.4	15.8	16.0	16.5	16.5
80.7	14.5	16.0	16.9	17.4	17.9	18.5[2] *(15)*	
84.3	14.8	16.4	17.3	17.9	18.4	18.8[2] *(12)*	
92.5	16.3	18.5	19.9[2] *(6)*				
98.0	16.9	19.8	21.2[2] *(6)*				
Pinto (Initial moisture content 9.8%)							
%	%	%	%	%	%	%	%
11.0	8.2	7.2	6.8	6.6	6.5	6.2	6.2
22.4	9.0	8.3	8.2	8.0	8.0	7.8	7.8
33.0	9.8	9.4	9.2	9.1	9.0	8.9	8.9
42.8	10.2	10.1	10.1	10.1	10.1	10.1	10.1
53.3	10.9	11.1	11.2	11.3	11.4	11.4	11.4
64.4	11.9	12.8	13.2	13.4	13.5	13.7	13.7
75.3	12.8	14.1	15.1	15.8	16.2	16.7	16.7
80.7	13.3	15.0	16.3	17.3	18.0	18.4[2] *(12)*	
84.3	13.2	15.2	16.7	17.7[2] *(8)*			
92.5	14.0	16.9	19.2[2] *(6)*				
98.0	14.0	18.5	20.6[2] *(6)*				

[1] By 33rd week this value had decreased to 6.0.
[2] Mold growth first observed; development time given in parentheses.
[3] By 32nd week this value had decreased to 5.9.
[4] By 32nd week this value was still 7.7.

course be duplicated in bulk-storage conditions of commercial practice. The varieties that showed the fastest increase in moisture under experimental conditions would likely show the fastest increase, if stored at high humidities, under commercial conditions; but the actual rate for the same temperature would probably be slower because of decreased circulation of air.

The data reported here were obtained for beans stored at 25° C. At higher temperatures for a given humidity, the rates of change in moisture probably would be greater but the actual equilibrium moisture content probably would be less as judged by results reported for other substances. For example, dehydrated eggs *(7)*, cotton, silk, and wool *(11)*, and wheat *(4)* all showed that at constant relative humidity, the equilibrium moisture content decreased with increasing storage temperature.

LITERATURE CITED

1. Association of Official Agricultural Chemists. *Official Methods of Analysis.* (7th ed.), Washington, D. C., p. 192 (1950).
2. Brockington, S. F., Dorin, H. C., and Howerton, H. K. Hygroscopic equilibrium of whole kernel corn. *Cereal Chem.*, **26**, 166-173 (1949).
3. Christensen, C. M., Olafson, H. H., and Geddes, W. F. Grain storage studies. VIII. Relation of molds in moist stored cottonseed to increased production of carbon dioxide, fatty acids, and heat. *Cereal Chem.*, **26**, 109-128 (1949).
4. Gane, R. The water content of wheats as a function of temperature and humidity. *J. Soc. Chem. Ind.*, **60T**, 44-46 (1941).
5. Karon, M. L. Hygroscopic equilibrium of cottonseed. *J. Am. Oil Chem. Soc.*, **24**, 56-58 (1947).
6. Karon, M. L., and Adams, M. E. Hygroscopic equilibrium of rice and rice fractions. *Cereal Chem.*, **26**, 1-12 (1949).
7. Makower, B. Vapor pressure of water adsorbed on dehydrated eggs. *Ind. Eng. Chem.*, **37**, 1018-1022 (1945).
8. Makower, B., Chastain, S. M., and Nielsen, E. Moisture determination in dehydrated vegetables. Vacuum oven method. *Ind. Eng. Chem.*, **38**, 725-731 (1946).
9. Morris, H. J., Olson, R. L., and Bean, R. C. Processing quality of varieties and strains of dry beans. *Food Technol.*, **4**, 247-251 (1950).
10. Stokes, R. H., and Robinson, R. A. Standard solutions for humidity control at 25° C. *Ind. Eng. Chem.*, **41**, 2013 (1949).
11. Wilson, R. E., and Fuwa, T. Humidity equilibria of various common substances. *Ind. Eng. Chem.*, **14**, 913-918 (1922).
12. Wink, W. A., and Sears, G. R. Instrumentation studies. LVII. Equilibrium relative humidities above saturated salt solutions at various temperatures. *Trans. Amer. Paper and Pulp Inst.*, **33**, 96A-99A (1950).
13. Wolf, M. J., Buzan, C. L., MacMasters, M. M., and Rist, C. E. Structure of the mature corn kernel. II. Microscopic structure of pericarp, seed coat, and hilar layer of dent corn. *Cereal Chem.*, **29**, 334-348 (1952).

The Browning of Canned Bread Crumb[a]

R. A. LARSEN,[b] R. B. KOCH,[c] AND J. J. McMULLEN

Quartermaster Food and Container Institute for the Armed Forces, Chicago, Illinois

(Manuscript received March 30, 1954)

The crumb of canned bread turns brown when stored for long periods of time. It appears that this discoloration is the result of the Maillard reaction since the removal of sugar from the formula minimizes the development of the brown color.

A great amount of work has been done on the browning reaction and its relationship to food problems. These studies have been the subject of several reviews *(6, 7)*. Recently the importance of this reaction to bread baking has been appreciated. Bartram *(2)* found the browning phenomena to be involved in the formation of crust color. Other workers *(9)* accounted for the loss of certain amino acids in bread by sugar-protein interaction. Still others associated the browning reaction with changes in bread flavor *(1)*.

Canned white bread that has been stored several months develops a noticeable and undesirable brown color in the crumb. Much work has been done to discover the cause of this brown color and a means of preventing it. This work led to the hypothesis that the browning of bread crumb is the result of a sugar-protein condensation reaction and that, if sugar could be removed, the browning would be stopped. This paper reports the results of experimental work designed to test this hypothesis.

MATERIALS AND METHODS

Canned bread was made according to Military Specification MIL-B-1070B *(8)*. The formula was as follows:

Ingredient	Parts by weight
Flour	100.00
Water	50.00 (variable)
Yeast	2.00
Salt	1.75
Sugar	8.00
Shortening	12.00
Buttermilk solids	2.00
Edible lactic acid	0.30 (variable)

The bread was made by the 100% sponge method. It was baked in the can, the lid being sealed immediately after baking. The pH of the bread used in this study was 4.8, the moisture content, 33%. The vacuum in the can was not less than 25

[a] This paper reports research undertaken by the Quartermaster Food and Container Institute for the Armed Forces, and has been assigned number 465 in the series of papers approved for publication. The views or conclusions contained in this report are those of the authors. They are not to be construed as necessarily reflecting the views or indorsement of the Department of Defense.

[b] Present address: Pillsbury Mills Inc., Minneapolis 2, Minnesota.

[c] Present address: J. R. Short Milling Co., Chicago, Illinois.

inches. It is important to maintain this minimum vacuum in canned bread because bread in cans having less vacuums has an unusual grey cast after storage that masks its normal appearance.

The effects of different ingredients were studied individually by varying each one in concentration while using the normal concentrations of other ingredients. Variations in flour, yeast, and water were not studied.

The bread was stored at temperatures of 100° ± 2° F. The color of the crumb was measured initially and after periodic intervals using a Hunter-Color and Color Difference Meter. This instrument measures the hue in terms of 4 colors—blue, green, yellow, and red. Minus "a" signifies green and plus "a," red. Minus "b" is blue and plus "b," yellow. The most saturated color would have a value of 100, the least saturated, 0. In addition, the brilliance of these colors is measured in terms of luminous reflectance (Rd). The brightest value would be 100, the least bright, 0. Thus, for any one color measurement, 3 values were obtained, a, b, and Rd. These values represented the hue, hue intensity, and brilliance. All 3 attributes were involved in the browning of bread crumb.

For each measurement, a sample of hand shredded bread crumb was used. Enough crumb was added to a round 2¼-inch diameter cuvette so that it was filled to a height of ¾ inch. The instrument was standardized against a white porcelain panel having the following color attributes, Rd = 85.4, a = −0.4, and b = +1.0. The cuvette was placed over a light source having a cross section of 2¼ inches, and readings were made using the large area illuminator of the instrument. Since the heat of the light source was intense and could increase the browning, all readings were made in less than one minute. Table 1 lists typical results obtained in this study.

TABLE 1

Replicate readings of bread crumb color using the Hunter-Color and Color Difference Meter

Sample	Rd [1]	a [2]	b [3]
1	49.1	+0.0	+19.1
	48.6	+0.0	+19.0
	48.6	+0.2	+19.8
	48.5	+0.0	+19.7
2	55.6	+0.1	+19.0
	55.0	+0.1	+19.1
3	65.0	−1.8	+13.5
	64.7	−1.9	+13.8

[1] Rd equals reflectance.
[2] + a is red, − a is green.
[3] + b is yellow, − b is blue.

TABLE 2

Changes in the color of canned bread stored at 100° F.

Months	Rd [1]	a [2]	b [3]
0	65	−1.7	+13
2	60	−0.5	+17
4	55	+0.4	+20
6	51	+1.1	+21

[1] Rd equals reflectance.
[2] + a is red, − a is green.
[3] + b is yellow, − b is blue.

The standard error of the Rd values was 0.30, of the "a" values 0.026, and of the "b" values 0.32.

RESULTS

Ingredient study. The crumb color of canned bread made according to the normal formula was measured at periodic intervals. Results presented in Table 2 show that as the bread crumb grew browner, changes occurred in the hue, its intensity, and in the reflected brilliance. It appears that the browning of bread may be accompanied by a shift of hue from greenish-yellow to a more intense reddish-yellow and by a decrease in brightness. The bread crumb did not appear off-color at the second month. At the fourth month, the bread crumb was definitely brown.

Storage studies were made on bread made by formulae from which single ingredients including shortening, buttermilk, salt, and sucrose had been removed.

The data in Table 3 indicate that removal of sucrose from the bread had a marked effect on the color of bread after 6 months' storage at 100° F. Not only was a degree of brightness retained but also the shift in hue to red was prevented and the intensity of the changes in yellow minimized.

Because of this striking result both buttermilk and sucrose were eliminated since the former contains about 50% lactose. The results are presented in Table 4.

TABLE 3

Effect of eliminating various ingredients on the browning of bread crumb

Missing ingredients	Months of storage	Rd [1]	a [2]	b [3]
	100° F.			
None	0	65	−1.7	+13
None	6	51	+1.1	+21
Salt	6	48	+1.2	+21
Shortening	6	52	+1.1	+22
Buttermilk solids	6	53	+0.9	+21
Sucrose	6	58	−0.2	+17

[1] Rd equals reflectance.
[2] + a is red, − a is green.
[3] + b is yellow, − b is blue.

TABLE 4

Effect of removing both sucrose and buttermilk on the browning of bread crumb

Missing ingredients	Months of storage	Rd [1]	a [2]	b [3]
	100° F.			
Buttermilk and sucrose	6	56	−1.0	+15
Sucrose	6	56	−0.7	+16
Buttermilk	6	51	+1.2	+21

[1] Rd equals reflectance.
[2] + a is red, − a is green.
[3] + b is yellow, − b is blue.

The bread made without sucrose and buttermilk showed only slightly less color change during storage than did the bread which had no added sucrose—which indicates that at low concentrations, lactose and the other ingredients in buttermilk have little effect on browning.

Sugar concentration. The striking effect of sugar on the browning of bread led to a study of the effect of sugar concentration. Both sucrose and glucose were studied since both are used extensively in bread baking. The results in Table 5 confirmed the effect of the sugar on the color of the crumb. As the concentration of sugar increased, the brilliance decreased, and hue and saturation increased. In order that some visual perception might be gained as to the depth of the browning reaction, a sugar series is shown in Figure 1.

TABLE 5

Effect of sugar concentration on the browning of bread crumb after six months of storage

Sugar	Sucrose			Glucose		
Concentration [4]	Rd [1]	a [2]	b [3]	Rd	a	b
0	58	−0.2	+17	58	−0.2	+17
1	57	−0.2	+17	56	−0.1	+18
2	57	+0.2	+18	55	+0.4	+19
4	56	+0.6	+19	54	+0.9	+20
6	52	+1.2	+21	51	+1.4	+21
8	51	+1.1	+21	48	+1.9	+21
10	48	+1.7	+22	46	+2.0	+21
12	49	+1.6	+21	41	+3.0	+19

[1] Rd equals reflectance.
[2] + a is red, − a is green.
[3] + b is yellow, − b is blue.
[4] Based upon flour as 100%.

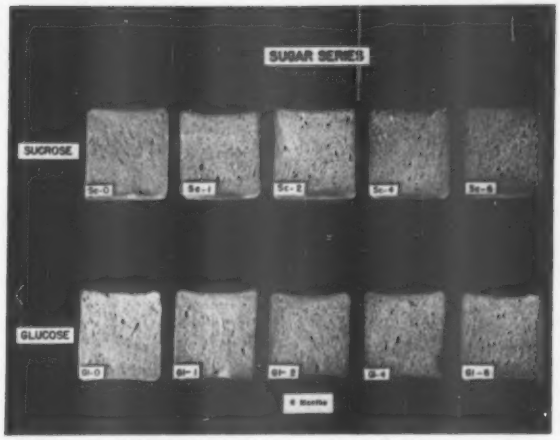


Figure 1. The effect of 0, 1, 2, 4, and 6% glucose or sucrose on the browning of bread crumb.

DISCUSSION

Work by Stenberg and Geddes *(10)* associated a decrease in amino nitrogen and an increase in reducing compounds with an appearance of levulinic acid and hydroxymethylfurfural as bread crumb browns. Work with model systems gave similar results. These workers felt the need for confirmatory studies but were hampered by lack of adequate techniques. The work reported in this paper supports the contention that the browning reaction in canned bread is a true sugar-protein interaction.

It is not surprising that the elimination of sugar from bread lessens the development of a brown color in bread crumb stored for long periods of time. Similar cases are recorded for eggs *(4)* and for potatoes *(7)*. A study on the toasting qualities of bread which showed the striking effects of increasing sugar concentration *(3)* might also have suggested the present study. That some success was obtained in minimizing the color formation at lower sugar concentrations is most likely explained by the work of Koch, Smith, and Geddes *(5)*. These workers showed that very little reducing sugar remains in the dough after baking unless the added sugar is above 2½%.

The activity of nonreducing sucrose in the browning reaction is undoubtedly the result of hydrolysis by the yeast. Yeast rapidly converts sucrose into glucose and fructose *(5)*, both of which are reducing sugars.

Although the browning of bread crumb can be minimized by employing no sugar, bread contains carbohydrate reducing groups which are constantly being replenished by enzyme action prior to baking. Thus the browning of canned bread crumb can be lessened but probably not prevented by reducing the sugar in the formula.

Acknowledgment

The technical assistance of Mr. J. Cryns, QM Food and Container Institute for the Armed Forces, is gratefully acknowledged.

LITERATURE CITED

1. Baker, J. C., Parker, H. K., and Fortman, K. L. Flavor of bread. *Cereal Chem.*, **30**, 22-30 (1953).
2. Bertram, G. L. Studies on crust color. I. The importance of the browning reaction in determining the crust color of bread. *Cereal Chem.*, **30**, 127-138 (1953).
3. Johnson, J. A. Dextrose as a sugar agent in baking. *Bakers' Digest*, **26**, 71-74 (1952).
4. Kline, L., Sonoda, T. T., Hanson, H. H., and Mitchell, J. H. Relative chemical, functional, and organoleptic stabilities of acidified, and glucose-free whole egg powders. *Food Technol.*, **7**, 456-462 (1953).
5. Koch, R. B., Smith, F., and Geddes, W. F. The fate of the sugars in bread doughs and synthetic nutrient solutions undergoing fermentation by bakers' yeast. (In press).
6. Lea, C. H. The role of amino acids in the deterioration of feed; the browning reaction. *Chem. Ind.*, **9**, 155-158 (1950).
7. Mitchell, J. H., and Peterson, M. S. (editors). *Contributions of Browning Research to Ration Item Stability.* Research and Development Associates. (August, 1952.)
8. Military Specification (Chicago Quartermaster Depot). Bread, Canned. MIL-B-1070B (1953).
9. Rosenberg, H. R., and Rohdenbey, E. L. The fortification of bread with lysine. *J. Nutrit.*, **45**, 593-598 (1951).
10. Stenberg, R., and Geddes, W. F. Study of the physical and chemical changes occurring in bread during storage. Quartermaster Rep. No. 10, File No. C-300 (1949).

The Tenderization of Peas During Vining[a]

J. C. MOYER

Department of Food Science and Technology, Cornell University, Geneva, New York

L. J. LYNCH AND R. S. MITCHELL

Division of Food Preservation and Transport, Commonwealth Scientific and Industrial Research Organization, Homebush, Australia

(Manuscript received October 15, 1953)

The effect of viner speed on the physical condition of peas was studied using the Maturometer for the measurement of changes in texture. The amount of injury was shown to vary directly with the beater speed. The rate of change in Maturometer values was independent of variety and maturity, and identical for the commercial and the experimental viner.

During the course of pea canning investigations in Australia, a number of observations made on viner operation have suggested that peas are tenderized to varying degree depending upon beater speed. Maturometer readings at optimal harvest time *(2)* of hand shelled peas were found to be higher than comparable peas recovered from a commercial viner or from a laboratory huller. Also, representative vine samples from identical crops were passed through two commercial viners set at different operational speeds and gave further evidence from maturometer readings of the validity of the observation.

The physical measurement of maturity by the several commercial instruments designed for that purpose is evaluated chiefly by reference to alcohol insoluble solids (AIS) *(1)* and the taste test. When tenderization is of such magnitude as to affect the readings of physical instruments, their relationship with AIS may be partly obscured, and the value of the rapid determination of quality consequently diminished. On the other hand since efficient viner operation represents the compromise between economic pea recovery and minimal damage as evidenced by bruising and fragmentation, it is possible that physical instruments may be used effectively for the controlled operation of viners. The subject was, therefore, deemed sufficiently important to warrant investigation and a detailed study was made at Geneva during the 1953 season using a commercial size viner, an experimental viner and a laboratory huller.

VINER CONSTRUCTION AND OPERATION

The essential components of a viner are a hexagon reel which slowly revolves about a smaller and more rapidly moving drum bearing a series of beaters. Vines are fed into the outer reel which is enclosed by rubber screens attached to longitudinal ribs. The latter elevate the vines through a 60° arc before they drop into the path of the beaters moving in the same direction as the reel. Through the impact of the beaters on the vines the pods are distorted, and the peas are freed to escape through the screens. Little variation is possible in the speed of the outer reel since at low speeds the vines would not be lifted high enough, while centrifugal force at higher speeds is reputed to carry them beyond the correct zone of impact. The beater speed on the other hand is often varied to effect complete threshing, since overmature and immature peas require more impact than those at optimal harvesting condition. Another factor determining the extent of the threshing action is the angle at which the beaters are mounted on the cylinder. With no pitch to the beaters the vines will continue to rotate within the reel, whereas glancing blows from partially turned beaters will propel them through the reel. In some viners provision is made to vary the pitch of the beaters while in others a fixed angle is maintained. For this study the angle of the beaters was not changed and thus all samples received the same number of blows, though the force of impact varied with the beater cylinder speed. The main variable of this study was the speed of the beater cylinders in both viners.

The commercial viner used in this work was a steel type[b] equipped with a variable speed transmission and tachometer on the beater cylinder, and a mechanism for the external adjustment of the beater angle. Prior to the pea season tachometer readings were calibrated wtih a speed indicator[c] over a wide speed range. The angle of the adjustable beaters was set to deliver 24 blows to the vines as they passed through the reel. Variations in the beater speed were obtained through adjustment of the variable speed transmission.

An experimental viner was designed and constructed at the New York State Experiment Station (Geneva) using half-scale commercial dimensions and making minor variations where practical. Like the commercial viner it was equipped with a variable speed transmission to the beater cylinder and a calibrated speedometer. On this unit the pitch of the beaters was fixed, and the rate at which the vines travelled through the reel was determined by raising or lowering the feed end of the viner frame. A more complete description of its construction will appear elsewhere *(3)*.

The laboratory huller[d] resembles a viner in miniature having a screen covered outer reel which rotates about a shaft supporting a series of beaters. In this unit the beater shaft turned at a fixed speed of 425 r.p.m. and the beaters were turned at fixed angles varying from 2½° to 8½°.

EXPERIMENTAL

Three series of tests were conducted solely with the experimental viner, and a further test was undertaken in which both experimental and commercial viners were used.

Series A: Vines from a planting of Ace peas were treated in lots of 20 kg., no particular care being taken to ensure that sample lots were comparable. Each sample was fed into the experimental viner at a uniform rate of 0.2 kg. per minute approximately.

Discharged vines were recovered and again fed into the threshing cylinder thereby doubling the effective length of the

[a] Journal Article No. 941, New York State Agricultural Experiment Station, approved September 14, 1953.

[b] Model 1635 manufactured by Chisholm-Ryder Co., Inc., Niagara Falls, N. Y.

[c] Model 104 manufactured by L. S. Starrett Co., Inc., Athol, Mass.

[d] Model B Junior huller, manufactured by Sinclair-Scott Co., Philadelphia, Pa.

viner. Vining was continued until residual material was completely discharged before subsequent samples were treated. Peas recovered from the viner were cleaned, and peas smaller than size grade 2 were separated from the otherwise ungraded sample, which was then submitted for maturometer index (M.I.) determination. Results from this series are shown in Table 1.

TABLE 1
Effect of viner speed on the maturometer index of Ace and Perfected Freezer peas

Viner speed r.p.m.	Maturometer index	
	Series A (Ace)	(Perfected Freezer) Series B
100	371	.....
140	344	.....
160	.....	270
180	319	.....
200	.....	250
220	304	.....
240	.....	233
260	261	229
280	.....	202
300	235	178
340	235	163
380	235	.....

Series B: This test was similar in all respects to the procedure adopted in Series A, but on this occasion 3 replicates were threshed at 300 r.p.m. Individual M. I. readings for these samples were 181, 192 and 160. Mean values at 300 r.p.m. are included in Table 1.

Series C: Samples of Perfected Freezer variety were treated once only in the experimental and commercial viners. Known weights of vines varying from 13.3 to 22.1 kg. were used. In this test precautions were taken in the field to mix the cut vines in such a way that all samples were as nearly comparable as possible. A measure of sample variability was made by using five replications in the commercial viner at 159 r.p.m., and three replications in the experimental unit at 280 r.p.m. In the former case the M. I. range was 211 to 227 with a mean value of 219. The experimental unit gave a range of values for M. I. from 218 to 222 with a mean of 219. Tenderometer readings were obtained from all samples.

One vine sample was shelled by hand to obtain figures for minimal injury, and an additional sample was stripped of pods which were passed through the laboratory huller. Alcohol insoluble solids contents were determined on canned material from all treatments. Table 2 gives results from series C.

TABLE 2
Effect of hand shelling, hulling, and viner speed on the maturometer index of Perfected Freezer peas

Viner speed r.p.m.	Maturometer index	Tenderometer reading	Percent alcohol insoluble solids
Commercial			
149	219	111	12.9
159	219	118	13.4
170	211	121	14.3
180	211	116	14.1
190	193	115	12.7
200	191	117	13.7
Experimental			
240	236	114	13.6
260	220	118	13.6
280	219	119	13.8
300	208	117	14.0
320	195	117	13.5
Huller			
425	195	119	13.1
Hand shelled	319	118	13.5

Series D: Vines of the Superior variety were used in a replicated speed test of the experimental unit. As in Series C vines were well mixed in the field, after which they were fed once through the viner at 4 selected speeds using 3 replications on each occasion. Alcohol insoluble solids values were determined on the canned material. The results are set out in Table 3.

DISCUSSION AND CONCLUSIONS

Series A was intended to be exploratory in nature to confirm (or not confirm) observations made on the effect of excessive viner speeds. From the commercial and experimental relationships given in Table 2, it may be deduced that the peas used in Series A were approximately M. I. 250 and therefore fully mature at the time of harvest. They were, in consequence, not as susceptible to injury as less mature peas, and exhibited maximum tenderizing effect at 300 r.p.m.

Tests carried out in Series B were designed for observation of the behaviour of peas at a less mature stage than those of Series A. The peas were harvested at M. I. 200, or about 1.5 days earlier than in the first test. The amount of damage at speeds above 280 r.p.m. was represented by a drop in maturometer value of 39 as compared with a reduction of 17 from the calculated M. I. 250 equivalent of 280 in Series A.

TABLE 3
Effect of viner speed on the maturometer index of Superior peas

Observation	240	Viner speed, r.p.m.		320	L. S. D.*
		260	280		
Maturometer index					
1	217	215	191	184	
2	224	222	191	187	
3	240	222	197	188	
Mean	227	219.7	193	186.3	14.7
Alcohol insoluble solids content, percent					
1	12.1	12.5	12.7	12.8	
2	11.9	12.4	11.0	12.1	
3	12.7	12.1	11.8	12.6	
Mean	12.2	12.3	11.8	12.5	N. S.

* Least significant difference at .01 level.

Series C was planned to establish the relation between injury in a commercial viner with that in the experimental unit, and to obtain, through partial replication of comparable vine samples, a reasonable measure of sample variability.

The peas used in this test were intermediate in maturity between those of the two previous tests as indicated by the M. I. reading of 219 at 280 r.p.m. The reduction of M. I. 24 from this point was relatively small, but in this trial the vines were passed only once through the experimental viner. The M. I. values from both viners suggest that the 280 to 340 r.p.m. range in the experimental unit is equivalent to the standard 150 to 200 r.p.m. range in the commercial viner.

Series D was designed to obtain a more precise assessment of sample to sample variation in M. I. values within a restricted range of viner speeds. Differences in A. I. S. contents between treatments in Series C and also in Series D were not significant.

Throughout the experimental work the inverse relationship between M. I. values and viner speed was apparent. Tenderometer readings were made in Series C, but these do not seem to reflect in any way the phenomenon of tenderization. The maturometer and the tenderometer are both represented as measuring

texture or firmness in a sample of peas, and the explanation of the difference in behaviour of these instruments is obscure. A possible theory is that a preliminary compaction of the sample occurs in the tenderomter prior to shear, and that the value obtained is for the compressed mass rather than a summation figure for the individual components of the sample. Should this hypothesis be correct the initial tenderization due to viner action would probably be negligible in relation to the physical effect of compression. Such a theory does not necessarily assume that measurements of maturity by tenderometer are invalid; but merely that it cannot be used to assess the effect on peas of a range of viner speeds. The maturometer, on the other hand, has been shown to give true summation values for the individual components within the sample, and hence might be expected to evaluate truly the effect of viner speed.

The relation between M. I. and viner speed (S) for all four series of experiments was found to be highly significant. Mathematical treatment of results is shown in Table 4, and the data are graphically presented in Figure 1. By contrast the relationship between tenderometer readings and viner speed was non-significant for the single set of observations made in Series C. An analysis of variance of the replicated speed test (Table 3) shows that the major part of the differences in recorded M.I. may be attributed directly to differences in viner speed, and not to sampling variation.

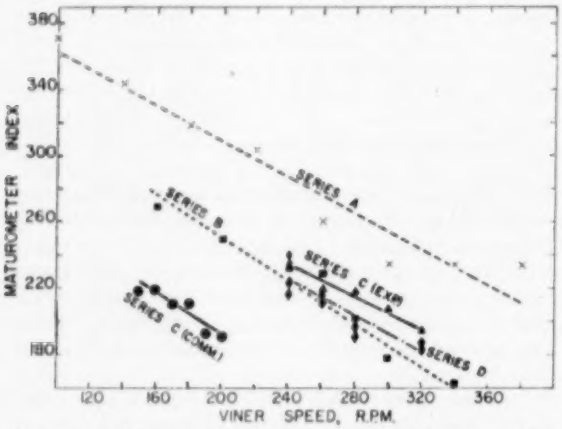


Figure 1. Viner speed and maturometer index relationship.

TABLE 4

Maturometer index and viner speed regressions and correlations

Series	Viner	Regression		Correlation coefficient (r)
		Equation	Standard error of estimate	
A	experimental	M.I. = 416.8 — 0.54S	13.10	—0.97
B	experimental	M.I. = 383.0 — 0.66S	12.10	—0.95
C	experimental	M.I. = 351.0 — 0.48S	9.10	—0.97
C	commercial	M.I. = 321.0 — 0.64S	5.00	—0.90
D	experimental	M.I. = 355.0 — 0.54S	15.12	—0.87

The results obtained throughout this series of experiments emphasize the need for careful control of beater speed, in order to avoid losses due to split skins in processing lines, and to prevent unnecessary texture deterioration in the finished product. Operational control of viners should have as its target the maximal though not necessarily the total recovery of peas from the pod, since damage to peas is an economic factor of primary importance. The control of viner speed is exercised through tachometer indication, and this should be regarded as an essential feature of viner installation. A number of tachometers observed on commercial pea viners are inadequate for precision control, since the operational range of 150 to 200 r.p.m. is restricted to a small section of the dial. It is strongly recommended that viner tachometers be such that they can be read with accuracy to 5 r.p.m. at a distance of 3 yards.

The rate of viner feed and the number of beats are also factors to be considered together with beater speed in economic viner operation, and it is proposed that these matters should form the subject of further viner investigation.

LITERATURE CITED

1. Kertesz, Z. I. The chemical determination of quality of canned green peas. N. Y. S. Agr. Exp. Sta. Tech. *Bull. 233* (1935).
2. Lynch, L. J., and Mitchell, R. S. The definition and prediction of the optimal harvest time of pea canning crops. C.S.I.R.O. Aust. *Bull.* (1935). (In press.)
3. Moyer, J. C. (Unpublished data, 1953.)

An Exploration of the Effects of Strong Radio-Frequency Fields on Micro-organisms in Aqueous Solutions

GEORGE H. BROWN AND WENDELL C. MORRISON
Radio Corporation of America, RCA Laboratories Division, Princeton, New Jersey

(Manuscript received September 19, 1953)

Radio-frequency power generators have been widely used in many industrial heating operations. Limited applications have been made in the treatment of food, where internally induced heat has been used to inactivate enzymes, as well as to pasteurize or sterilize the material. Many writers have speculated concerning specific effects of electric fields on micro-organisms other than the heating effect. The present authors have carried out a series of experiments, using a wide range of frequencies to treat specimens which varied widely in conductivity. It is the purpose of this paper to describe the methods developed for estimating electric field intensities and temperature rise, as well as to display typical test results.

The literature contains many references to the effect of radio-frequency fields on bacteria. Some indicate lethal effects from relatively weak fields; others indicate a complete absence of lethal effect. To those of us who were working to apply radio-frequency generators to new and profitable uses, the prospect of causing great destruction of micro-organisms, or possibly of bringing about sterilization of aqueous solutions by means of radio-frequency fields — either weak or strong — was very appealing. If it were possible to sterilize by strong fields applied for a short enough time to prevent heating of the solution, many interesting products might result. For instance one might speculate about pasteurization of milk with no carmelized flavor, sterilization of containers, and even sterilization of products after sealing in containers. One could visualize a milk-pasteurization plant where capped bottles of milk were carried by a conveyor belt and passed betwen metal plate electrodes excited by a small radar transmitter. Pleasant thoughts of this type led the authors into the lengthy investigation described in this paper.

A background of useful experience has been established by devoting several years to the study of radio-frequency generators for heating applications. Basic information had been determined for such applications as heat-treating of metals, heating of plastic preforms, and gluing of wood. The work to be reported in this paper was done at the RCA Laboratories, but some of the work was carried on in cooperation with other scientists skilled in the field of bacteriology.

One of the first projects that we investigated in this field was the pasteurization of milk. Ordinarily, pasteurization is accomplished by heating the milk to 143° F. (61.5° C.) for 30 minutes, or by heating to 161° F. (71.5° C.) and holding for approximately 16 seconds. In our experiments, it was hoped to produce pasteurization by raising the temperature to some higher value than the above with a correspondingly shorter time. Using a technique already described by Brown, Hoyler and Bierwirth *(2)*, the milk was preheated by conventional heat exchangers to 140° F. (60° C.) and then exposed to a radio-frequency field of 700 volts per centimeter for 0.067 second, producing a temperature rise of 60° F. or a final temperature of 200° F. (93° C.). An experiment was conducted with the same apparatus to learn if the electric field *per se* contributed to the destruction of the bacteria. This was accomplished by omitting the preheating. Raw milk at a temperature of 70° F. (21° C.) was exposed to a field of 700 volts per centimeter for 0.067 seconds. This exposure resulted in the same temperature increment with the final temperature of 130° F. (54.5° C.). The bacteria count of the final product did not differ materially from the raw count.

Work in an entirely different field led to some related experiments. One of the early problems in the production of penicillin was the concentration of the very weak liquor. At that time, penicillin was produced as an aqueous solution and it was generally believed that even slightly elevated temperatures were very destructive to penicillin. The method devised by Brown, Bierwirth and Hoyler *(1)* for extracting this surplus water was to boil the liquor, contained in a large glass flask, by means of radio-frequency power, with the temperature kept below that considered destructive by maintaining a partial vacuum over the liquid. From the known factors, it was possible to estimate the field in the liquid. Using this equipment, a bacteria-laden solution was exposed to a field of 20 volts per centimeter and a maximum temperature of 80° F. (26.5° C.) for 10 minutes. There was no change in bacteria count. The experiment was repeated, but this time the boiling was maintained for one hour. In this case, it was necessary to replenish the liquid with sterile water at frequent intervals. Again there was no significant change in bacteria count.

At about this time, a number of writers claimed substantial destruction of micro-organisms by radio-frequency fields, exclusive of the heating effect. In a review of the literature, we came to one general conclusion. We noted that those acquainted with the bacteriological part of the work often erred in their radio-frequency techniques, while bacteriologists with whom we consulted indicated that they did not approve of the bacteriological manipulations described by radio-engineer authors. In this paper, we shall try to be specific about our electrical techniques, and sufficiently complete concerning the bacteriological techniques so that they can be checked by those who consider them-

selves expert in this field. Much of our early work was wasted because of a lack of knowledge of certain basic facts and skills in the field of bacteriology. Again, a review of the work of others indicates a wide variation in the frequencies used and in the method of applying the field. One extreme is illustrated in an article which concludes with the statement that even solutions in the same room with the radio-frequency equipment enjoyed some destruction of bacteria.

One of the more detailed accounts of work in this field is an article by Fleming *(3)*. Apparently, he secured large destruction with 10-watt oscillators treating 10 c.c. of an inoculated aqueous solution for periods of 0.5 to 3 minutes, and at frequencies from 10 to 300 megacycles. We did not agree with this author, even to the extent that his method of applying the field should be effective. However, not wishing to overlook any such simple solutions, we attempted to duplicate some of his work. An oscillator operating at 300 megacycles and capable of a power output in excess of 1.5 kilowatts was used. As suggested by Fleming, 10 c.c. of inoculated solution was flowed over agar in a petri dish. This dish was then placed between electrodes which formed the capacitance portion of a parallel-resonant circuit coupled to the output of the oscillator. The plate voltage to the oscillator was reduced until the power approximated that used by Fleming. The experiment was repeated several times with increasingly longer exposures and finally with extremely high voltages between the electrodes. We also placed the petri dish in an induction field for a similar series of experiments. In each and every case there was no destruction of bacteria.

There have been many theories advanced as to how bacteria in an aqueous solution can be destroyed by

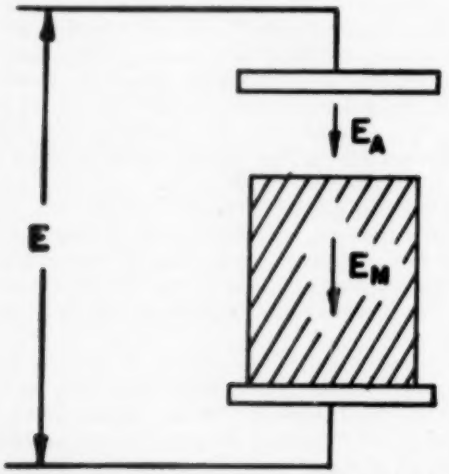


Figure 1. Dielectrics in series in an electric field.

radio-frequency fields exclusive of the thermal effect. Regardless of the theory, one is inclined to believe it essential to apply the field to the solution. The following discussion will show the futility of attempting to produce high-intensity fields in an aqueous solution by any such method as that used in the experiment described above.

Figure 1 shows diagrammatically two metal plates to which are applied the radio-frequency field. Between the plates is the material to be treated and an air gap. The radio-frequency generator will cause a current to flow through the air gap and the material, producing an electric field in the air gap of intensity E_A and an electric field in the material of intensity E_M. The following symbolism is useful in developing the ratio of these two field intensities.

E_A = electric field intensity in air (volts per centimeter).
E_M = electric field intensity in the material (volts per centimeter).
I = current density in air (and in the material) at the surface between the air and the material (amperes per square centimeter).
Y = admittance (mho-centimeters).
σ_M = conductivity of the material (mho-centimeters).
f = frequency (cycles per second).
ω = $2\pi f$ radians per second.
p_o = permittivity of free space (8.85×10^{-14} farads).
ϵ = dielectric constant of the material.

At the boundary, in the air space, the current density is

$$I = E_A Y_A \qquad (1)$$

and at the boundary, in the material, the current density is

$$I = E_M Y_M \qquad (2)$$

Then from (1) and (2),

$$\frac{E_A}{E_M} = \frac{Y_M}{Y_A} \qquad (3)$$

But

$$Y_M = \sigma_M + j\omega p_o \epsilon_M \qquad (4)$$

and

$$Y_A = j\omega p_o \qquad (5)$$

so (3) becomes

$$\frac{E_A}{E_M} = \epsilon_M + \frac{\sigma_M}{j\omega p_o} \qquad (6)$$

From this equation it is evident that if the material being treated is principally water with a dielectric constant of approximately 80 and a conductivity close to zero, the ratio of the field intensity in air to the field intensity in the material is approximately equal to the dielectric constant of the material. Since air will withstand a field of approximately 25,000 volts per centimeter, the field in the material cannot be greater than 25,000/80 or 315 volts per centimeter. At the other extreme, in the case of milk with a dielectric constant of 80 and a con-

ductivity of 0.005 mho-centimeters, the equation shows that for frequencies less than 1000 megacycles,

$$\frac{E_A}{E_M} = \frac{\epsilon_M}{\omega \rho_0} = \frac{10{,}000}{f_{MC}} \qquad (7)$$

Thus for a frequency of 50 megacycles, the maximum voltage that could be developed across the material without producing a breakdown in the air gap would be 125 volts per centimeter.

From the above argument, we were convinced that to achieve high electric fields in aqueous solutions, the voltage should be applied directly to the material with no air gap in series. To accomplish this, a test capsule was devised consisting of a pyrex glass cylinder capped securely at one end with a metal plate and a second metal plate arranged to be placed over the top. A small hole was drilled through the center of the top cap so the cylinder could be filled completely and then, when the top cap was put in place, any excess liquid came out through the vent hole. This gave the desired result so that not even an air bubble was left inside the capsule. Two different size capsules and the holder used with them are shown in Figure 2. Capsules were made using different diameters of tubing. The smallest capsule held 1.16 c.c., the next held 3.2 c.c., and the largest held

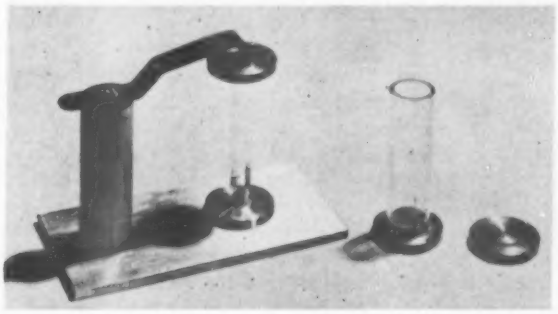


Figure 2. Two capsules and capsule holder.

6.5 c.c. After the first few experiments, the largest capsule was used exclusively. In the course of our experiments, we capped these glass cylinders with brass, copper, aluminum and stainless steel to make sure that the results were not influenced by the cap material.

Since the field intensity was considered to be of prime importance, a reliable method of measuring this field was essential. The method consisted of determining the shunt resistance of the solution in the capsule and the temperature rise of the solution due to a particular radio-frequency treatment. From these values and a knowledge of the dimensions of the capsule, the field intensity could be calculated.

The resistance of the capsule was determined by using a Boonton Radio Corporation Q-Meter, Model 160A. The basic circuit of this device is shown in Figure 3. The instrument measures the resonant rise in voltage across a parallel-tuned circuit and it can be shown that this measurement is related to the Q of the circuit. Figure 4 shows the two conditions encountered: (a) the

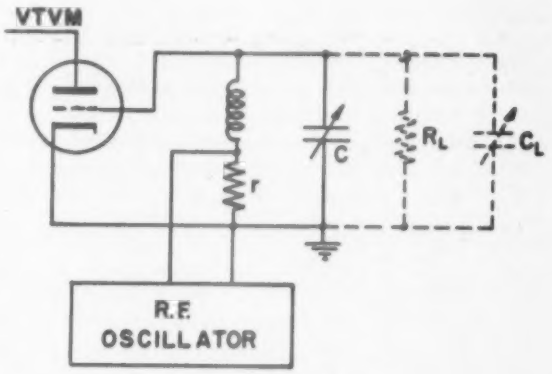
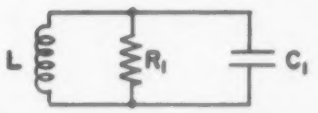
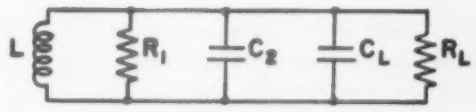


Figure 3. Q-meter circuit.



(a) THE RESONANT CIRCUIT



(b) WITH CAPSULE ADDED

Figure 4. Two circuits encountered.

resonant circuit alone, and (b) the resonant circuit with the capsule in parallel. The mathematical development of the formula for the parallel resistance of the capsule is as follows:

$$Q_1 = \frac{R_1}{X_{C_1}} \qquad (8)$$

$$Q_2 = \frac{R_2}{X_{(C_2 + C_L)}} \qquad (9)$$

$$\frac{1}{R_2} = \frac{1}{R_1} + \frac{1}{R_L} \qquad (10)$$

or

$$\frac{1}{R_L} = \frac{1}{R_2} - \frac{1}{R_1} \qquad (11)$$

From (8), (9), and (11) if $C_1 = C_2 + C_L$

$$\frac{1}{R_L} = \frac{1}{Q_2 X_{C_1}} - \frac{1}{Q_1 X_{C_1}} = \frac{Q_1 - Q_2}{Q_1 Q_2 X_{C_1}} \qquad (12)$$

and

$$R_L = \frac{1}{2\pi f C_1} \cdot \frac{Q_1 Q_2}{(Q_1 - Q_2)} \qquad (13)$$

where

R_L = the total resistance of the capsule (ohms).
f = the frequency at which the measurement is made (cycles per second).
Q_1 = the measured Q of the test circuit alone.
Q_2 = the measured Q of the test circuit with the capsule and its holder in parallel.
C_1 = capacity for resonance while measuring Q_1 (farads).
C_2 = capacity for resonance while measuring Q_2 (farads).

In our experiments, the holder for the capsule was included in the Q_1 measurement so its effect was lumped in with the capacity C_1. The range of Q encountered was from 50 to 400. Also, the difference in capacity between C_1 and C_2 was never greater than 2% so it could be neglected.

Once the resistance of the capsule had been determined, the specific resistivity is easily calculated from the capsule dimensions.

$$\rho = \frac{R_L A}{b} \tag{14}$$

where

ρ = resistivity (ohm-centimeters).
R_L = resistance of the capsule (ohms).
A = cross-sectional area of the capsule (square centimeters).
b = length of the capsule (centimeters).
V = volume of the capsule (cubic centimeters).

Since it was difficult to measure accurately the cross-sectional area, we preferred to use the volume which could be determined easily. Equation (14) was modified as follows.

$$\rho = \frac{R_L A}{b} \cdot \frac{b}{b} = \frac{R_L V}{b^2} \tag{15}$$

With the knowledge that one calorie equals 4.187 watt-seconds, the energy given to the sample is 4.187 $V(\mu_2 - \mu_1)$ watt-seconds where μ_2 is the final temperature of the liquid and μ_1 is the starting temperature of the liquid in degrees centigrade. If this is done in time $\Delta t = (t_2 - t_1)$ seconds then the power is

$$P = \frac{4.187 V(\mu_2 - \mu_1)}{\Delta t} \text{ watts} \tag{16}$$

and the field is

$$E = \sqrt{PR_L} \text{ volts per centimeter.} \tag{17}$$

Using the method described, a survey was started to determine the effect of frequency on viability. Tests were made with d.c., 60 cycles, 190 kilocycles, 26 megacycles, and 65 megacycles. First tests were made with relatively low voltages and short time so as not to warm the solution excessively. Then they were repeated with much higher voltages but with the fields interrupted for periods long compared to the *on* time to allow the solution to become cool. The generators in this case were operated as blocked-grid oscillators. These gave short pulses at a repetition rate of from 200 to 1000 pulses per second and duty cycles of 3% to 15%. That is, the oscillators were delivering power to the solution for only from 3 to 15% of the total elapsed time. Later an automatic timer was constructed which operated at much longer times both *on* and *off* and enabled us to control more accurately the heating and cooling. The temperature of the solution was measured by means of a thermocouple. The initial temperature was determined by pouring the capsule full of the test solution, plunging the thermocouple into the middle of the liquid, and reading the temperature. This sample was then discarded, and a new one poured and treated. A sterile pipette was used to remove a 1 c.c. sample of the treated solution which was flowed over a previously prepared agar plate, and then the thermocouple was again plunged into the remaining liquid in the capsule to determine the final temperature. These initial experiments were very encouraging. Some destruction was noted in many cases. The most effective, however, was produced by a 26 m.c. oscillator capable of 2 kw. output pulsed *on* for 0.2 second and *off* for 30 seconds. Using this oscillator and pulsing technique, many plates were made. In view of later developments, this was the time during which we learned proper bacteriological techniques.

After consulting several bacteriologists, we ordered from the American Type Culture Collection slants of several types of bacteria, such as *Escherichia coli, Bacillus prodigiosus (serratia marcescens), Bacillus subtilis,* and *Bacillus stearothermophilus.* These were selected on the basis of harmlessness, ease of counting and culturing and as being typical. To simplify the work, we soon abandoned experiments with all except *E. coli.* We also investigated the relative merits of Tryptose agar, Desoxycholate agar and Nutrient agar. We finally did the majority of the work using Nutrient agar.

With regard to incubation temperature, we noted a lack of uniformity among the several experts consulted so we decided to make a few tests ourselves. From the results obtained with our particular equipment, we decided upon and consistently used 37° C. Plates were counted after 48 hours incubation. One of the problems encountered was the development of a means of washing the capsules used for treating the bacteria. Because of the very large number of tests made per day, it seemed prohibitive to produce enough capsules so that they could be sterilized by an approved technique and then used only once. Furthermore, we found no satisfactory means of fastening the bottom cap to the glass tube that would withstand these sterilizing methods. At first, after using a capsule it was emptied, washed in tap water (which we had previously determined to have a plate count of 2 or 3 colonies per c.c.), and then rinsed with sterile water. Later on, this technique was suspect so we rinsed the capsule in Roccal solution prior to rinsing with the sterile water. Finally, we simply rinsed the capsule several times in tap water. In each case the cap

was given the same washing as the capsule. At no time did we find any difference in these methods, and therefore believe that even the last and simplest is entirely satisfactory. In the bacteriological field it appears common to perform experiments by using uncountable concentrations of bacteria and then making several dilutions after each experiment to reach countable plates. As a means of enabling us to make many more experiments per day by eliminating about two-thirds of the plates to be handled, we attempted to produce stock solutions of *E. coli* of known count. We presume that it is well known by those working in the field, but it was both amusing and discouraging to us to discover how very "unreliable" bacteria can be. About the time we thought we had a standardizing method, something would happen and again we would be lost. Our one consolation was no matter what concentration of bacteria we used, if a really effective method were found we would have either clear or countable plates.

We set out to examine the effect of radio frequency in terms of the field intensity used, the time of treatment, the conductivity of the solution and, to some extent, the concentration of bacteria in the solution. As we have indicated, our early work was encouraging. For example, Figure 5 shows the effect of increasingly stronger

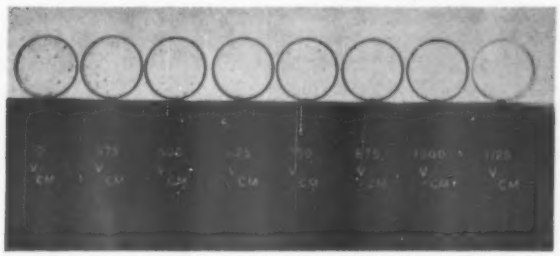


Figure 5. The effect of increasingly stronger fields on E. coli.

fields on *E. coli*. Data obtained from results such as are shown, plotted up into very interesting curves. A similar curve was obtained for the time of treatment and for the effect of conductivity (viability decreased with increasing conductivity). Up to this time we had been becoming more and more ambitious in expanding our field of research, but before publishing anything we knew that we must check these many experiments. Something had happened. A test in which results duplicated early work was an exception. In searching for an answer to this, we could find several differences. First we had made many plates by now and were much more proficient in this part of the work. Also, it was now in the fall of the year, rather than in the summer, which meant that ambient temperatures were lower and cooling of the test capsule was not such a problem. During the summer, we had been forced to cool the capsule by more and more complex methods which finally reached a peak when we blew air across dry ice and then directed it against the capsule. Such drastic methods as this, of course, were only necessary for the very high field strengths. The result of all this was that we were forced to be suspicious of our temperature effects. Because we had read that temperatures of the order of 130° F. (54° C.) were necessary in order to harm the bacteria being used, we had been operating around this temperature. We now decided to check this point for ourselves. Small test tubes were partially filled with an inoculated solution and then plunged into a large water bath maintained at some predetermined temperature. The test tube was agitated so that the solution within the test tube quickly assumed the temperature of the water bath. Samples were held at fixed temperatures for various intervals. The results, shown in Figure 6, were a shock to us because of the tremendous change in destruction in going from 50° to 55° C. and also the rapidity with which the lethal temperature took effect. With our pulsing techniques it was necessary to make the total elapsed time of treatment at least several minutes. This, of course, meant that the bacteria would be maintained at an elevated temperature for a considerable period of time, and, in view of the curves just obtained, these

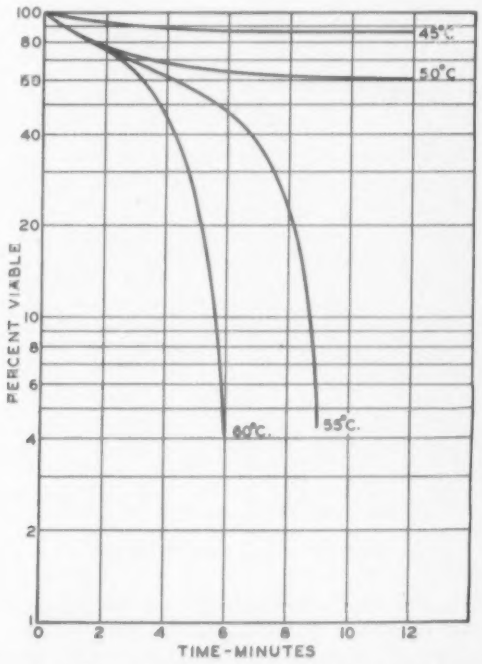


Figure 6. Time vs. viability for several water bath temps.

temperatures might well be lethal. We also discovered that the method utilized for taking out the one c.c. sample by inserting the pipette into the capsule might also lower the temperature a few degrees. An entirely new method was essential. The solution decided upon was to use one sample just for the purpose of determining the ultimate temperature encountered in a particular treatment. A capsule was filled with the test solution, the temperature measured with the thermocouple, and then given a particular R-F treatment. As rapidly as possible the temperature of the liquid was measured by inserting the small thermocouple wires into the liquid. Next, an identical capsule containing the

same solution was given the same treatment, and the one c.c. needed for plating was pipetted off. Experiment after experiment was performed in an attempt to duplicate our early work. Almost invariably there was no noticeable effect unless the final temperature exceeded the lethal temperature as indicated by Figure 6.

A rather complete summary of this later work is shown in Figures 7, 8, and 9. In Figure 7 are shown

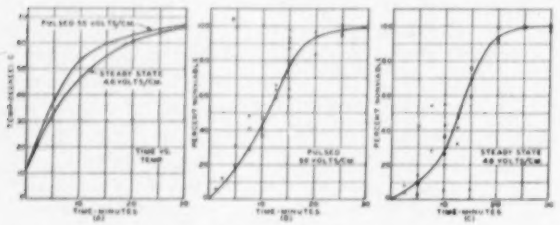


Figure 7. Undiluted E. coli broth.

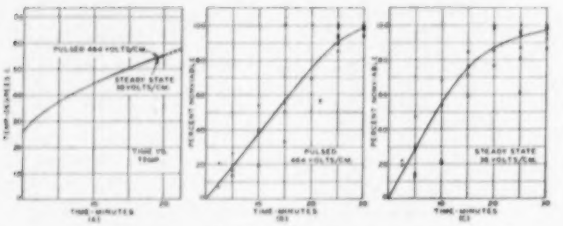


Figure 8. 10^2 : 1 dilution E. coli broth.

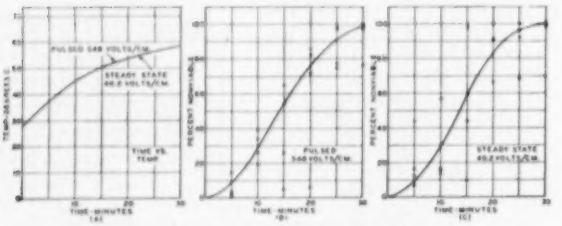


Figure 9. 10^6 : 1 dilution and salt.

results of a series of experiments in which the concentration of natural salts and bacteria was so great that the total resistance of the capsule was only 168 ohms. An attempt was made to produce by steady state application of a relatively low voltage a temperature rise identical to that produced by a higher voltage applied in pulses of 0.2 seconds *on* and 30 seconds *off*. The results are shown in Part A of this figure. Part B shows the effect of viability for the pulsed condition, and Part C the result of the steady state application. It is obvious that the curves are nearly identical and that non-viability is a temperature effect. In Figure 8 is shown the result of a similar set of experiments, but in this case the *E. coli* broth was diluted 100 to 1 with sterile distilled water, so that the resistance of the capsule was 20,680 ohms. Under this condition, both the steady-state voltage and the peak-pulse voltage are considerably higher. Again, the results obtained are nearly identical for the two conditions. Figure 9 shows a third set of experiments. In this case, the *E. coli* broth was diluted 10,000 to 1 to make the concentration of bacteria quite small, but the conductivity was changed by the addition of 5 mg. of NaCl per 100 c.c. of test solution to bring the capsule resistance to 27,860 ohms. It may be seen that there is no unusual effect attributable to the high pulse voltage. Also the treatment is not effective until lethal temperatures are reached.

In addition to the tests previously mentioned, we also made similar tests using a radar transmitter operating at a carrier frequency of 400 megacycles and producing 15 kilowattts of peak power in a pulse of 2 microseconds duration at a 1000-cycle repetition rate. Later we acquired a 600-megacycle radar transmitter which was also used. This transmitter gave 100 kilowatts peak power and either 1.5-microsecond pulses at a 600-cycle repetition rate or 5-microsecond pulses at 180-cycle repetition rate. We also used only the plate pulser of this transmitter which produced a 15,000 peak volts pulse for the time and repetition rates stated above. As before, the destruction obtained with these radar transmitters was negligible as long as the temperature of the test solution was kept at low values.

In conclusion, we should like to first observe that, to people who are accustomed to having their work follow exact mathematical equations, the behavior of bacteria may seem extremely erratic. Occasionally, the bacteria would be made non-viable by some particular treatment and a short time later the same treatment would appear to have no effect. This may have been caused by the particular state of the bacteria or may have been the result of previous treatment.

It has not seemed possible in this paper to discuss in detail the many experiments carried on in RCA Laboratories over a period of several years. We have attempted to give a description of the general approach and some detail concerning the measuring techniques. The net result of this volume of work has been to convince ourselves that no significant destruction of bacteria in aqueous solution occurs from the application of radio-frequency fields in the frequency range up to 600 megacycles, excepting of course the destruction brought about by thermal effects.

Acknowledgment

The authors wish to acknowledge the assistance of Dr. D. L. Trautman and Miss Marlies Muller in carrying out many of the experiments in this field.

LITERATURE CITED

1. Brown, G. H., Bierwirth, R. A., and Hoyler, C. N. Radio-frequency dehydration of penicillin solution, *Proc. I.R.E.*, 46W, (February, 1946).
2. Brown, G. H., Hoyler, C. N., and Bierwirth, R. A. *The Theory and Application of Radio-Frequency Heating.* 1947, D. Van Nostrand Company, Inc., New York, N. Y.
3. Fleming, Hugh. Effect of high-frequency on micro-organisms. *Elec. Eng.*, **63** (1), 18 (1944).

The Influence of Lipids on Self-Dispersion and on Ease of Dispersion of Milk Powder[a,b]

W. K. STONE, T. F. CONLEY,[c] AND J. M. McINTIRE
Quartermaster Food and Container Institute for the Armed Forces, Chicago, Illinois

(Manuscript received March 24, 1954)

Effective reconstitution of dry whole milk in water in preparation of a fluid product which simulates fresh homogenized milk depends upon rapid dispersion of the milk powder constituents. The role played by the lipid materials in self-dispersion and in dispersibility [d] has not been determined; yet their physical properties indicate their potential importance. For example, in the liquid state, certain lipids may alter the surface tension of the aqueous medium and the interfacial tension of powder particles. When some lipids are subjected to temperature change, which permits melting and solidification, different crystalline forms may occur.

Milk fat, a term used to represent all of the lipids present in milk, is chiefly a mixture of different glycerides. As a result, its transition from the solid to the liquid state is not sharp, but occurs over a temperature range. Rogers *et al (9)* report that the melting range of milk fat is 28°-36° C. (82.5°-96.8° F.).

In spray-dried whole milk powder the milk fat is distributed among the other powder materials in the form of globules. Globule size depends to a large extent on the processes employed in manufacturing. During reconstitution these globules are dispersed, along with the other powder constituents, and finally are resuspended as an emulsion in the serum of the reconstituted milk.

This research, a part of a program designed to improve the dispersibility of dry whole milk, was undertaken to investigate the influence of lipids on self-dispersion and on ease of dispersion by low energy stirring.

REVIEW OF THE LITERATURE

The effect of heat on the solubility [e] of milk proteins has received the attention of many investigators *(4, 12)* but there is a lack of published information on the influence of milk fat and other lipids on dispersibility of dried milks. However, in connection with investigations on dispersibility, various methods for estimating and studying certain dispersing properties, (wettability, for example) were developed which reveal some of the approaches used in dispersibility studies.

Kleinert *(5)* described a method for measuring wettability, based on self-dispersion as determined by a turbidimetric technique. Later, Ashworth *(1)* proposed a wettability test in which the percent solids self-dispersed in 5 minutes under specific conditions was designated as percent wettable. Both of these investigators found that whole milk powders with good wetting properties, as determined by their techniques, were more soluble than those with poor wetting properties.

Nickerson *et al. (8)* estimated *wettability* in terms of the time required for milk powder particles to sink below the surface of water on which they were dusted, and *dispersibility* by noting the time required for particles to lose their identity when immersed in water at room temperature. The National Dairy Research Laboratories *(7)* developed a turbidimetric method for estimating self-dispersion and a shaking method for determining dispersibility. Cone and Ashworth *(3)* developed a new quantitative manual shaking method for determining the solubility of milk powders in which they attempted to simulate home kitchen conditions in respect to temperature, concentration, and agitation.

Tracy and Wilster *(11)* estimated reconstitutability by the appearance of undispersed material remaining after filtration of the reconstituted product through a black organdy pad having 74 meshes per inch; completeness of reconstitution was estimated (a) from the solubility index, (b) by microscopic examination of the milk film, and (c) by the appearance of the reconstituted milk after shaking one pint of the product in a quart bottle.

As pointed out in the preceding review, the characteristic property of milk powder to self-disperse in water, especially in reference to a time factor, has been associated by various workers with the wettability of the product. No established method for quantitative estimation of ease of dispersion of milk powder in water by low energy stirring is in evidence in the literature. Preliminary data obtained in connection with this study indicated, however, that the dispersing properties of whole milk powder are affected by the milk fat.

EXPERIMENTAL

Determination of self-dispersion. Apparatus: The apparatus for estimating self-dispersion consisted of a screening and testing device. The screening device was made by securely fastening a circle of screen 150 mm. in diameter to a ring, which was supported by a separate ringstand, 2 mm. above the top rim of the Buchner funnel of the testing apparatus. The function of the screen is to aid in manual distribution of the milk powder. The

---

[a] Presented at the Thirteenth Annual Meeting of IFT, Boston, Mass., June 21, 1953.

[b] This paper reports research undertaken by the Quartermaster Food and Container Institute for the Armed Forces and has been assigned No. 452 in the series of papers approved for publication. The views or conclusions contained in this report are those of the authors. They are not to be construed as necessarily reflecting the views or indorsement of the Department of Defense.

[c] Present address: W. F. & John Barnes Company, Rockford, Illinois.

[d] The term *dispersibility* has developed into common use, especially in connection with research and development of dry whole milk at the Quartermaster Food and Container Institute. Stegeman *(10)* used redispersion of dry whole milk to designate the act of preparing fluid milk from milk powder and dispersibility to imply a characteristic of a powder to redisperse. In this paper, dispersibility is used to designate ease of and completeness or extent of dispersion of milk powder in water with agitation to form a product which simulates fresh homogenized milk. The scope of this investigation did not include a study of completeness of dispersion.

[e] Solubility has been used to designate the ability of milk powders to disperse in water to form a solution, suspension, or emulsion, which simulates the physical characteristics of natural milk; however, the term is generally recognized as a misnomer.

effectiveness is controlled, to a large extent, by the size of the screen, and a ¼-inch and 14 mesh screen were selected for use when testing whole and nonfat milk powders, respectively. The self-dispersion testing device consisted of an 82 mm. inside diameter Buchner funnel, a large stopcock, a coarse (40-60 micron) fritted glass Buchner type funnel (62 mm. I. D.), and a filtering flask. These parts were assembled as shown in Figure 1.

Procedures. (a) The powder was tempered (during at least 24 hours) to the desired temperature (the standard temperature of powder for testing was 70-75° F.). (b) Fifteen grams of tempered powder were distributed (by screening) over the surface of 90 ml. of water (standard temperature 70-75° F.) which was contained in the Buchner funnel of the testing apparatus. (c) After 3 minutes, the mixture was rapidly drawn into the filtering flask with the aid of vacuum (Ca 16 inches) and was diluted to 200 ml. in a volumetric flask. (d) Total solids were determined in a 20 ml. aliquot, and this weight times 10 represented the self-dispersion value for the sample under analysis.

Figure 1. Apparatus for determining self-dispersion of milk powder.

Determination of ease of dispersion. Ease of dispersion by manual stirring was determined by the following procedures: (a) A representative sample of the powder under analysis was screened through a 14-mesh screen. (b) Fifteen grams of the screened powder were added to 90 ml. of water (standard temperature 70-75° F.) contained in a 250 ml. beaker. (c) The mixture was stirred for a designated stirring time with an ordinary teaspoon[f] and then filtered with the aid of vacuum (Ca 16 inches) through a coarse (40-60 micron) fritted glass Buchner type filtering funnel.[g] (d) The filtrate was diluted to 200 ml. and grams of total solids were determined in a 20 ml. aliquot. This value times 10 represented the disperson value for any one designated stirring time. (e) Ease of dispersion was estimated from the dispersion values resulting from 10, 20, 30 and 45 seconds stirring.

Total solid determinations. Twenty ml. of representative sample from the 200 ml. volume of diluted milk filtrate were transferred to a tared aluminum foil evaporating dish and were held in a well-ventilated oven at 70-75° C. until the solids appeared dry. Drying was completed in a convection current oven in accordance with time and temperature conditions for determination of total solids in milk as recommended in AOAC *(2)*.

[f] An attempt was made to disperse as much powder as possible, but care was exercised not to splash out of the beaker.

[g] Since difficulty in filtering was frequently encountered when testing high heat nonfat milk powder *(6)*, a 210 micron screen was used instead of the coarse fritted glass funnel when testing this type of powder.

Preparation of milk powder samples. The premium grade whole milk powders used in this study were made in accordance with MIL-M-1495A *(6)*. Those made in this Laboratory were dried with a Type N-3 Model N-25 G. Ind. turbulaire spray drier.[h] The inlet temperature was 350° F. and the outlet temperature, 185° F. The evaporating capacity with this temperature differential was approximately 10 pounds of water per hour. The atomizer pressure was about 60 p.s.i. with an estimated flow rate of air of 9 cubic feet per minute. The atomizer nozzle was a type *N* design IA 3.

RESULTS AND DISCUSSION

Influence of temperature of powder on self-dispersion. To obtain information on the effect of temperature of whole milk powder on self-dispersion, portions of a sample of premium grade product were adjusted to various temperatures between 5 and 140° F. then, self-dispersion in water at 75° F. was determined on each tempered sample at its respective temperature. The results appear in Table 1.

TABLE 1

Effect of temperature of dry whole milk powder on self-dispersion in water at 75° F.

Temp. of powder	Self-dispersion	Temp. of powder	Self-dispersion
° F.	*grams*	*° F.*	*grams*
5	0.846	80	0.684
15	0.816	85	0.762
35	0.786	95	0.893
40	0.806	100	6.337
50	0.793	110	7.776
60	0.695	120	8.320
70	0.613	140	8.786

These data (Table 1) show that self-dispersion varied widely over a range of temperatures. Between 5 and 70° F. a slight decrease in self-dispersion occurred and from 70 to 95° F. a slight increase occurred. However, between 95 and 100° F. (near the melting range of milk fat) a seven-fold increase in self-dispersion occurred. From 100 to 140° F. there was a marked but more gradual increase in self-dispersion of the dry whole milk.

In order to obtain additional data on the effect of temperature of dry whole milk on self-dispersion, five premium grade spray-dried powders, manufactured by different concerns, were each divided into two lots. One lot was tempered to 72° F. and the other to 120° F.; self-dispersion in water at 75° F. was determined on each sample at these respective temperatures. The whole milk powders which were tempered to 120° F. gave higher self-dispersion values than those tempered to 72° F. Four were 7 times higher, and one was 2.5 times higher.

Self-dispersion of dry whole milk may be affected by temperature fluctuations. To demonstrate the effect on self-dispersion of heating to 120° F., and cooling slowly to room temperature, 3 powders were tested at temperatures of 72° and 120° F. in water at 75° F. Subsequently, the samples which were heated to 120° F. were allowed to cool at room temperature for 1, 2, 3, 4, 5 and 20 hours. At the end of each cooling time, self-disper-

[h] Manufactured by the Western Precipitation Corporation, Los Angeles.

sion was again determined on each sample. The results are shown in Table 2.

These data demonstrate that slow cooling of whole milk powder from temperatures above the melting range of milk fat to temperatures below this temperature

TABLE 2

Change in self-dispersion of dry whole milk due to heating and cooling water temperature 75° F.

Temp. of powder	Tempering time	Self-dispersion measurements		
		Sample L-2	Sample L-3	Sample L-4
° F.	*hours*	*grams*	*grams*	*grams*
72 (initial)	12	0.694	0.657	0.503
120	12	9.524	8.897	2.398
85	1	7.831	.....	.....
80	2	6.027	.....	.....
80	3	3.795	.....	.....
80	4	0.639	.....	.....
80	5	0.616	3.757	0.390
76	20	0.488	0.999	0.467

range decreases self-dispersion, and that the decreases occur over a period of several hours. Of interest was the fact that different self-dispersion values, as compared to the initial value at 72° F., were obtained after heating and cooling. This difference may be attributable to a different physical state of the newly solidified milk fat, and will require further study, particularly along lines of melting and solidification of mixed glycerides.

At powder temperatures below the melting range of milk fat, nonfat milk powders generally disperse more rapidly than whole milk powders. To demonstrate the effect of temperature of nonfat powder on self-dispersion in water at 75° F., samples of two spray-dried products were tempered to temperatures varying between 5° and 120° F.; and self-dispersion tests were made on each tempered sample. The results are presented in Table 3. These data show that increasing the temperature of nonfat milk powder increased self-dispersion; however, a large, sharp increase did not occur near the melting range of milk fat as occurred with whole milk powder.

TABLE 3

Effect of temperature of powder on self-dispersion of nonfat milk powder

Sample No. L-1 Fat content 1.25%		Sample No. L-2 Fat content 1.4%	
Temp. of non-fat powder	Self-dispersion in water at 75° F.	Temp. of non-fat powder	Self-dispersion in water at 75° F.
° F.	*grams*	*° F.*	*grams*
5	1.765	5	3.157
35	1.759	35	3.833
72	1.896	72	4.484
100	1.681	100	4.953
120	1.928	120	5.239

Influence of temperature of water on self-dispersion. To determine the effect of temperature of water on self-dispersion, whole and nonfat milk powders at a temperature of 72° F. were tested using water at various temperatures between 35 and 150° F.

The results (Table 4) show that self-dispersion of dry whole milk was little affected by temperature of water up to 90° F., but between 90 and 100° F. there occurred a large, sharp increase in self-dispersion, and between 100 and 140° F., a gradual increase in self-dispersion occurred.

Temperature of water had a different effect on self-dispersion of nonfat dry milk than it had on self-dispersion of dry whole milk. The nonfat powder demonstrated a gradual increase over the entire temperature range studied. In water at 150° F., self-dispersion of nonfat powder was comparable to that of whole milk powder in water at 100° F. The different self-dispersion values which were obtained at the various water temperatures in connection with whole and nonfat milk powder, indicate that temperature of water just above the melting range of milk fat acts to greatly increase self-dispersion of dry whole milk.

TABLE 4

Influence of temperature of water on self-dispersion of whole and nonfat milk powder at 72° F.

Temp. of water	Self-dispersion of milk powder	
	Whole	Nonfat
° F.	*grams*	*grams*
35	0.682	1.042
40	0.663	1.444
50	0.683	1.364
60	0.731	1.580
70	0.786	1.855
80	0.782	2.170
85	0.811	2.599
90	0.963	2.861
95	1.420	3.364
100	8.177	3.444
110	9.489	4.110
120	.....	6.102
140	10.391	.....
150	.....	8.445

In order to further delineate the influence of lipids on self-dispersion, a 20% fat powder in which corn oil replaced milk fat was made. Samples of this product were tempered to various temperatures between 5° F. and 120° F. and self-dispersion was determined at each temperature in water at 75° F. The results appear in Table 5.

TABLE 5

The influence of corn oil on self-dispersion of milk powder in water at 75° F.

Temp. of powder	Self-dispersion	Temp. of powder	Self-dispersion
° F.	*grams*	*° F.*	*grams*
5	5.799	72	6.071
35	5.921	90	6.380
50	5.845	100	6.511
		120	6.492

At powder temperatures below the melting range of milk fat, higher self-dispersion values were obtained for corn oil powder than were obtained for normal dry whole milk, but at powder temperatures above the melting range of milk fat, normal dry whole milk gave higher self-dispersion values (Table 1) than corn oil powder (Table 5). The rapid self-dispersion of cold corn oil powder may be attributable to the presence of liquid corn oil at 75° F., the temperature of the water.

Effect of various levels of milk fat on self-dispersion. Milk powders, which varied in percent fat

from 7.5 to 48.3, were prepared in this Laboratory. The amount of fat in the dried product was controlled by standardizing the skim milk concentrates with homogenized cream. The temperature on introduction to the dryer was 160° F. and drying was done in the Turbulaire dryer. Each powder was analyzed for percent fat and moisture; and was tested for self-dispersion at 72° F. in water at 75° F. The data obtained are presented in Table 6.

TABLE 6

Effect of various levels of milk fat on self-dispersion of milk powder

(Powder temperature, 72° F.; water temperature, 75° F.)

Sample No.	Self-dispersion	Percent moisture [1]	Percent fat [1]
	grams		
Nonfat control	4.559	2.3	1.4
F-1	1.578	2.0	7.4
F-2	1.448	2.2	9.8
F-3	0.955	2.2	27.0
F-4	0.527	2.3	34.9
F-5	0.351	1.6	48.3
M-1 [2]	0.909	2.0	26.2

[1] A.O.A.C. Procedures.
[2] Premium Grade Whole Milk Powder.

The effect of fat content on this characteristic dispersing property under these temperature conditions is shown by the large difference in self-dispersion between the nonfat control and Sample F-1. As the fat content of the powder was increased, self-dispersion decreased. In order to permit comparison with premium grade whole milk powder *(6)* the analysis of M-1, a commercial product, was also presented in Table 6. Samples F-3 and M-1 compared closely in self-dispersion and also in fat content.

It is probably coincidental that the two samples F-3 and M-1 (Table 6) gave nearly the same values for self-dispersion, even though the fat levels are approximately the same. For example, as is shown in Table 7, when 36 samples of premium grade dry whole milk were tested for self-dispersion, values between 0.303 and 1.209 were obtained. However, the majority of the samples were included in the ranges .500-.599, .600-.699, .700-.799, and .800-.899. The temperature of powder and water at

TABLE 7

Distribution of self-dispersion values of dry whole milk

Range in grams	Number of samples	Percent of total samples
1.000–plus	1	2.7
.900–.999	3	8.3
.800–.899	5	13.9
.700–.799	13	36.1
.600–.699	5	13.9
.500–.599	4	11.1
.400–.499	2	5.6
.300–.399	3	8.4
Total	36	100.0

the time of analysis was 72 and 75° F. respectively. These data indicate that factors other than the content of milk fat also affect self-dispersion.

Effect of temperature on ease of dispersion by stirring. Since temperature affected the self-dispersing characteristic property of dry whole milk, especially at the melting range of the milk fat, investigations were made as to the effect of temperature of dry whole milk on ease of dispersion by low energy manual stirring. To demonstrate this effect, 2 samples were taken from each of 3 lots of premium grade dry whole milk, and one sample from each lot was tempered to 72° F. and one to 120° F. Self-dispersion and ease of dispersion determinations were made in duplicate on each sample of powder at their respective temperatures using water at 75° F. The results which are average values appear in Table 8.

The expected increase in self-dispersion attributable to temperature of powder was obtained. Also, the effect of temperature of powder on ease of dispersion during

TABLE 8

Effect of temperature of dry whole milk on ease of dispersion in water at 75° F. by stirring

Sample no.	Temp. of powder	Self-dispersion in grams	Grams dispersed by stirring for:			
			10 sec.	20 sec.	30 sec.	45 sec.
D-2182	72° F.	0.752	5.675	9.862	10.423	11.486
	120	7.950	9.559	10.704	12.433	13.891
D-1383	72° F.	0.918	5.460	10.382	11.143	11.881
	120	7.660	9.718	10.919	12.257	13.151
D-1288	72° F.	1.221	6.082	11.142	12.037	12.661
	120	6.948	10.822	11.062	12.882	13.634

10 seconds stirring is clearly demonstrated. However, for the other stirring times, the temperature effect was not as evident by inspection of the data; therefore, analysis of variance was made on the results obtained for 20, 30, and 45 seconds agitation. The mean square deviation (duplicates) and the mean square variance attributable to temperature treatment together with their significant levels calculated through their F ratio appear in Table 9.

TABLE 9

Significant levels of variation on dispersion attributable to difference in temperatures of 72° F. and 120° F.

Stirring time	Mean square deviation (duplicates)	Mean square (variance attributable to temperature)	F ratio	Significant levels
seconds				%
20	.0965	0.563	5.83	5-10
30	.0695	5.250	76.00	.5
45	.0782	4.940	63.00	.5
Combined	.0805	9.238	115.00	.5

The variation in grams of powder dispersed attributable to temperature of powder is very definite when compared with variation due to error of replication except for 20 seconds stirring. For this stirring time the temperature differential was not clearly demonstrated with the available data.

The mean square (variance) attributable to time of stirring for all three times was 11.825 and that attributable to powder variation 2.551. The variance associated with length of stirring is comparable to the variance associated with temperature of powder, but both are considerably larger than the variance associated with the powders. However, all three sources of variance are

significant at the 0.5 percent level when compared with the error variance.

The time-temperature interaction mean square is 0.751 which is significant at the 0.5 percent level with respect to the error mean square, and the differential thus varies significantly under different lengths of stirring time for the 20-45 second range. When considering only 30 and 45 seconds stirring times, the mean squares for temperature, time, and their interactions are, respectively 10.188, 3.726, and 0.003. The first two are definitely significant, but the last is clearly negligible. In this range of stirring time, the temperature effect is more important than the effect of stirring time and there is no evidence that the temperature differential differs for the two stirring times.

These data (Table 8) are important in that they demonstrate that whole milk powder tempered to 120° F. dispersed more easily by manual stirring in water at a temperature of 75° F. than does whole milk powder tempered to 72° F. These powder temperatures, 120° F. and 72° F., are, respectively, well above and below the melting range of milk fat.

SUMMARY AND CONCLUSIONS

Tempering dry whole milk to temperatures which cause melting of milk fat increased self-dispersion. Slow cooling of dry whole milk from 120° F. to 76° F. acted to decrease self-dispersion; however, four to five hours were required to obtain new values comparable to initial values. Milk powder in which 20% corn oil was substituted for the milk fat, demonstrated a gradual increase in self-dispersion concomitant with an increase in temperature of powder; however, a sharp increase in self-dispersion failed to occur at or near the melting range of milk fat.

Temperature of the water near the melting range of milk fat caused a large increase in self-dispersion of whole milk powder. As the milk fat content of milk powder was increased, self-dispersion decreased. The powders were tested at 72° F. in water at 75° F. Seventy-five percent of the self-dispersion values resulting from analysis of 36 samples of premium grade dry whole milk were within the following ranges: .500-.599; .600-.699; .700-.799; and .800-.899 g. When the temperature of the water was constant at 75° F., whole milk powder tempered to 120° F. dispersed more rapidly by manual stirring than powder tempered to 72° F.

Acknowledgment

The authors wish to express their appreciation to K. R. Wood, Chief Statistician, QM Food and Container Institute for the Armed Forces, Chicago, for statistical analysis of the data.

LITERATURE CITED

1. Ashworth, U. S. A method for measuring the wettability of milk powders. *J. Dairy Sci.*, **35**, 481 (1952).
2. Association of Official Agricultural Chemists. *Official Methods of Analysis.* 7th ed., Washington, D. C., 1950.
3. Cone, J. F., and Ashworth, U. S. A new quantitative method for determining the solubility of milk powders. *J. Dairy Sci.*, **30**, 463-472 (1947).
4. Howat, G. R., and Wright, N. C. Factors affecting the solubility of milk proteins. II. The influence of temperature of reconstitution on protein solubility. *J. Dairy Research*, **4**, 265-272 (1933).
5. Kleinert, J. *Schweiz. Milchztg.*, **75**, 397-98 (1949).
6. Milk, Dry; Whole and Nonfat Solids. Military Specification, 31 July 1952. Chicago Quartermaster Depot, Chicago, Illinois.
7. National Dairy Research Laboratory, Inc., Oakdale, Long Island, New York. Methods for measuring the dispersibility of whole milk powders. Report No. 419. 1951. (Unpublished.)
8. Nickerson, T. A., Coulter, S. T., and Jeness, R. Some properties of freeze-dried milk. *J. Dairy Sci.*, **35**, 77-85 (1952).
9. Rogers, L. A., and Associates. *Fundamentals of Dairy Science.* 1928, The Chemical Catalog Company, Inc., New York, N. Y.
10. Stegeman, R. A. The dry milk industry. *Activities Report*, **1**, 230-236 (1948). Published by the Research and Development Associates, Food and Container Institute, Inc., Chicago, Ill.
11. Tracy, P. H., and Wilster, G. H. Factors affecting reconstitutability of dry whole milk. File DD-4, Report No. 4, Committee on Food Research Technical Reports. Quartermaster Food and Container Institute, Research and Development Branch, Office of The Quartermaster General. 1946.
12. Wright, N. C. Factors affecting the solubility of milk powders. Part I. The effect of heat on the solubility of milk proteins. *J. Dairy Research*, **4**, 123-141 (1932).

Consumer-Type Appraisal of Whole Egg Powders Stabilized by Glucose Removal (Yeast Fermentation) and by Acidification

HELEN L. HANSON AND LEO KLINE

Western Utilization Research Branch, Agricultural Research Service, United States Department of Agriculture, Albany 6, California

(Manuscript received February 22, 1954)

Relative preference for whole egg powder stabilized by glucose removal and by acidification has been determined for groups of 40 individuals by paired preference and hedonic-scale tests. Tests showed little difference in acceptability of the two types of eggs compared as scrambled eggs immediately after dehydration. During storage at 100° F. there was an increasing comparative preference for scrambled eggs prepared from the glucose-free powder, which was related to their superior stability.

The discovery of the beneficial effect of glucose removal on flavor stability of whole egg powders *(4)* and the demonstration that glucose-free egg powders are more stable than those produced by acidification *(5)* made it appear probable that glucose-free powder would be more suitable for Armed Forces' requirements than the acidified powder being used. Experiments were therefore conducted jointly by the Western Utilization Research Branch and the Quartermaster Food and Container Institute for the Armed Forces to determine whether this superior stability of glucose-free (fermented) egg solids is significant as measured by consumer-type tests and whether it is possible without loss of initial quality. The need for this comparison is further emphasized by the acceptance of glucose-free powders in domestic channels in contrast to acidified powder, which has found an outlet only in use by the Armed Forces. However, for military procurement, both the intended use of the powder as scrambled eggs and the special packaging conditions permissible under military specification (2% H_2O and gas pack) differ significantly from the comparable factors for powders designed for domestic use. Hence, the present study was undertaken to compare the two powders under the special conditions of interest in military procurement. The following report summarizes conclusions from sensory tests conducted at the Western Utilization Research Branch.[a]

Comparisons were made of the two types of powders under various conditions of moisture content, storage atmosphere, and storage temperature. Although most of the study involves eggs dried to 2% H_2O, limited comparisons of eggs dried to 3.5% H_2O were also included. The eggs dried to the lower moisture were packed in both N_2 and a mixture of N_2 and CO_2 to determine whether the inclusion of CO_2 had any advantage in promoting stability over use of N_2 alone. Eggs dried to the higher moisture were packed only in the mixture of the two gases. Since the Armed Forces require an egg powder that is usable after a year at 100° F. (37.7° C.), the consumer preference for two types of eggs held at that temperature was of greatest interest. However, the experiment also included limited comparisons of eggs stored at 40° F. (4.4° C.) and 70° F. (21° C.). Evaluation of flavor by trained-panel tests was included to determine differences in flavor stability and to assist in interpretation of consumer-type tests.

[a] Eggs for this experiment were purchased by the Quartermaster Food and Container Institute, Chicago, and were dried under the joint supervision of representatives of both laboratories.

SAMPLE PREPARATION

Whole egg pulp was obtained from current-receipt eggs in the spring. The eggs were broken on the same day the powders were prepared and the pulp was held at 40° F. until processing was initiated. Glucose-free powders were prepared by resting-cell yeast fermentation (at the time this study was undertaken, glucose oxidase was not available commercially) and acidified powders according to the military procurement specifications issued in 1950 *(7)*. Both processes have been adequately described elsewhere *(5)*. In the present case, the whole-egg pulps were pasteurized after the pretreatments for 1.5 minutes at 139-140° F. and spray-dried in a Rogers-type drier. The powders, which were collected at a temperature of about 70° F., were immediately transferred to 404 x 414 cans, in the amount of one pound per can, and the cans hermetically sealed. After being held overnight at 40° F., the cans were gas-packed by the solder-tip method. Residual oxygen in the "headspace" on cans selected at random immediately after gas packing was 0.2 vol. percent or less. The cans were held at between 0° and —20° F. until storage studies were initiated.

The experiment provided the following comparisons of the 2 powders at each storage temperature: (a) at 3.5% H_2O and gas-packed in 80% N_2 and 20% CO_2; (b) at 2.0% H_2O and gas-packed in 80% N_2 and 20% CO_2; (c) at 2.0% H_2O and gas-packed in 100% N_2. Because of unexpected variation in the moisture content of the glucose-free samples, some selection of samples was necessary. These were restricted to the critical comparisons at the 2% H_2O level and the 100° F. storage temperature, in which case glucose-free powders containing over 2.2% H_2O were discarded. This permitted glucose-free powders ranging in moisture content from 1.8 to 2.2% to be compared with acidified powders ranging from 1.6 to 2.2%. For the other comparisons the glucose-free powders averaged about 1.5% higher in moisture than their acidified counterparts.

CONSUMER-TYPE TEST METHOD

Preparation of scrambled eggs. The formulas used were as follows:

	Acidified eggs	Glucose-free eggs
Egg solids	140.6 g.	113.2 g.
Water	396.0 cc.	448.2 cc.
Milk, evaporated	99.0 cc.	80.2 cc.
Fat	23.4 g.	18.6 g.
Salt	2.29 g.	3.76 g.
Soluble pepper	0.48 g.	0.48 g.

Evaporated milk and water were combined and the sifted egg powder was added to a third of the combined liquids. The mixture was stirred until all lumps were removed. The remaining liquid was added slowly with stirring. Salt and pepper were added. Fat was melted in a double boiler, and the egg mixture was poured into the fat and cooked (with stirring) over boiling water. Later the double boiler was removed from direct heat, and the eggs were held over the hot water until and during serving. The above quantity served 40 individuals with 0.5-oz. portions.

The greater amount of salt in the glucose-free egg formula was needed to compensate for the amount present in the acidified eggs as the result of the acidification and neutralization process. Formulas containing different solids contents were required so that each egg type would be tested with a formula that produced optimum scrambled egg texture. The formulas were selected to give textures as similar as possible to that of scrambled fresh eggs. Identical textures were not produced in the two egg types, but defects such as wateriness and rubberiness were minimized. A bland hydrogenated fat was used. Newly opened cans were used at each withdrawal period.

Samples of scrambled eggs were not held longer than 20 minutes except when the effect of holding samples a longer time was being tested. In the latter cases the samples were held over hot water for 20 minutes. The water in the double boiler was then reheated to boiling temperature and the double boiler was again removed from the heat. Serving was completed within the next 20 minutes.

Selection of test subjects. For the consumer-type tests, individuals were excluded who had previously judged eggs in a panel situation, were technically familiar with eggs or egg products, or had any particular knowledge or interest in the results of the present experiment. Since the test subjects should be potential consumers of eggs, no attempt was made to overcome the resistance to participation that was met in persons who have such a strong dislike of scrambled eggs that they would not normally eat them. However, aside from those persons, who readily identified themselves, test subjects were selected without regard to their degree of liking for scrambled eggs. Within these restrictions selection was made from the laboratory personnel, and visitors were used whenever possible.

Paired preference test. One sample of acidified and one of glucose-free eggs stored under comparable conditions of moisture, atmosphere, and temperature were presented simultaneously for a preference decision. All 3 pairs comprising the 6 samples in the experiment were presented in one session, the order of pairs being systematically varied. Half-ounce portions were served. Cool water was provided for drinking, and no time limit was imposed. The complete test required approximately 40 responses on each pair of samples. In the calculation of results equal credit was given each sample in a pair when no preference was stated.

Hedonic-scale test. As this test has been described in detail *(6)*, only a general description is given here. Samples of scrambled eggs are presented and rated singly, and three are judged at each session. They are scored according to one of 9 descriptive terms ranging from *like extremely* to *dislike extremely*. Each term is assigned a number ranging from 9 at the *like* end of the scale to 1 at *dislike* end. One-ounce portions were served. Combinations and orders of samples were systematically varied.

TRAINED PANEL-TEST METHODS

Preparation of scrambled eggs. The formulas were as follows:

	Acidified eggs	Glucose-free eggs
Egg solids	30 g.	30 g.
Water	100 cc.	100 cc.
Salt	.....	0.31 g.

Samples were mixed and placed on a shaking machine for 15 minutes. The reconstituted samples were cooked (with stirring) in beakers on a steam bath until coagulated (approximately 5 minutes). This amount served 7 judges. As in the consumer-type tests, salt was added to the glucose-free eggs to give equivalent salt concentrations in both types. The samples were served in 50-ml. beakers covered with watch glasses. The beakers were kept warm in a water bath at approximately 52° C. (125.6° F.) during serving.

Selection of judges. Judges selected for these experiments were familiar with the off-flavors developed in egg solids and in a number of previous experiments had demonstrated their ability to detect them at low concentrations.

Test for initial flavor differences. The 3 experimental samples of each type of powder differed before storage only in moisture content or type of gas pack. However, since each of the 3 samples represented a different cut from the drying operation it was conceivable that there might be slight initial differences in flavor. This possibility was checked by serving the 3 samples of each type as coded samples along with a coded control to the trained taste panel. The 2% moisture samples packed in 80% N_2 + 20% CO_2 were arbitrarily used as controls. Glucose-free and acidified eggs were served separately at alternate taste periods so that flavor and texture differences between the 2 types of eggs would not influence judging of differences within each type. Each series of 4 coded samples along with a labeled control was presented 4 times to 7 judges. Samples were scored on a 10-point scale. The labeled control was given an intermediate score to permit scoring of more or less off-flavor in the coded samples. Significance of differences was tested by analysis of variance.

Test for differences in off-flavor of stored samples. Eight samples (6 experimental and 2 controls held at −20° F.) were judged according to the Balanced Incomplete Block Design, Plan 11.10 [Cochran and Cox *(2)*]. In this design the samples are judged 4 at a time for 14 times. The judges were instructed to grade the samples only on the basis of storage off-flavor. They were informed that 8 samples would be judged and that different combinations would be tested each day.

Samples were graded on a scale of 10 to 0, with a score of 10 indicating no storage off-flavor and a score of 0 indicating extreme storage off-flavor. A labeled control of each type was provided at each serving to minimize the possibility of confusing storage with initial foreign flavor.

Test for relative flavor stability of glucose-free and acidified egg solids. As this test has been described elsewhere *(3)*, only a brief description is given. Egg solids stored at 100° F. (37.7° C.) and control samples held at −20° F. (−28.9° C.) were mixed to give 4 levels of concentration of stored powder, 0%, 10%, 20%, and 30%. Stored acidified powder was mixed with acidified control; stored glucose-free powder was mixed with glucose-free control. The 4 levels of stored powder were coded and were judged in the presence of a labeled control of the corresponding egg type. The judges were told that the labeled control had no storage off-flavor, and they were asked to rank the 4 coded samples in order of increasing off-flavor. All flavor tests by the trained panel were conducted under sodium vapor lights.

Comparison of Initial Scrambled Egg Performance of Glucose-Free and Acidified Whole Egg Solids

Freshly prepared (i.e. unstored) glucose-free and acidified egg solids yielded scrambled eggs that were readily distinguishable in color, texture, and flavor. The acidified samples had a

lighter yellow color and the texture was somewhat granular, while texture of the glucose-free scrambled eggs was more firm and compact. Flavor differences between acidified and glucose-free eggs were distinct but not easily described. However, the trained panel was unable to distinguish any differences among the 3 samples of each type of egg. Thus, there was no original detectable difference due to moisture level or atmosphere.

Limited paired preference tests showed a slight preference for glucose-free powder before storage, indicating that no problems in acceptance of the unstored powders would be anticipated. When the maximum time before serving was increased from 20 to 40 minutes to correspond to possible military conditions, there was an increase of 6% in preference for glucose-free eggs.

Examination of adverse comments of individuals in the consumer-type tests showed that flavor and texture were the characteristics that most influenced preference. Those who disliked the texture of acidified eggs described it as *granular, mealy, crumbly,* and *rubbery;* those who disliked the texture of the glucose-free eggs described it as *tough, hard,* and *rubbery.* Adverse comments were made on the flavors of both kinds of eggs, but no descriptive terms were used consistently to describe the flavor of either type of egg. The original color difference between glucose-free and acidified eggs apparently did not affect preference to any extent.

Effect of Storage at 100° F. on Consumer Preference

The superior stability of glucose-free whole egg powder caused preference for it to increase with storage time at 100° F. The paired preference test results revealed a preference of approximately 3 to 1 for the 2% H_2O glucose-free powder after 9 months' storage. The preference increased to approximately 4 to 1 after 12 months (Figure 1). The preference for the

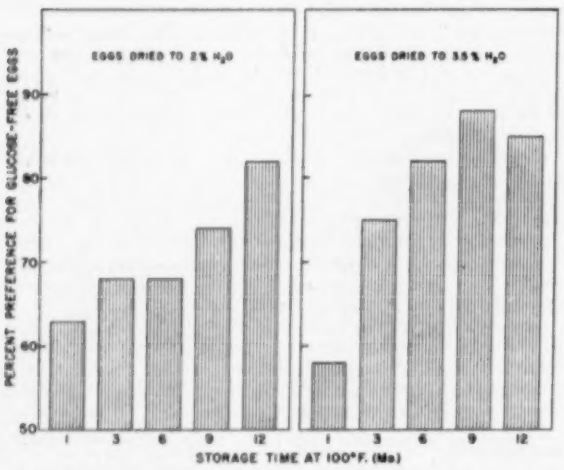


Figure 1. Effect of storage at 100° F. on preference for glucose-free over acidified egg powders.

3.5% H_2O glucose-free eggs was approximately 3 to 1 after 3 months' storage and 4 to 1 after 6 months. When the maximum time of holding the scrambled eggs before serving was increased from 20 minutes to 40 minutes, tests on 2% H_2O scrambles after one month's storage showed an increase of 7% in preference for glucose-free eggs.

The hedonic-scale test also showed increasing differences between ratings for glucose-free and acidified eggs after storage at 100° F. (Figure 2). The scale rating for glucose-free eggs was approximately 6 at each storage period. After 12 months, the 2% H_2O acidified eggs were scored 1.9 points lower than the comparable glucose-free eggs; the 3.5% H_2O acidified eggs were scored 3.3 points lower than the comparable glucose-free eggs.

Although the hedonic rating of the glucose-free 2% H_2O sample was no lower after storage for 12 months at 100° F. than it was initially, direct comparison of the ratings was not considered valid because of the possible influence of other samples tested at the same session on the rating. Thus, the glucose-free sample stored 12 months and tested at the same session as the seriously deteriorated acidified samples stored 12 months, might be expected to receive a higher rating than when tested in the presence of unstored acidified samples. Since sufficient low-moisture glucose-free egg held for 12 months was not avail-

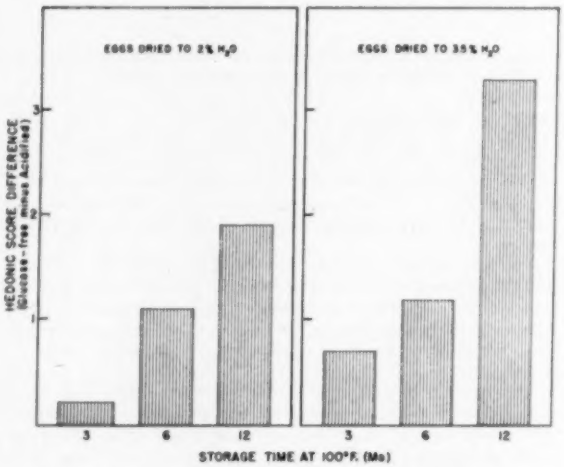


Figure 2. Effect of storage at 100° F. on difference between hedonic score ratings given glucose-free and acidified egg powders.

able for comparison with unstored control, a sample of the low-moisture glucose-free egg held for 18 months at 100° F. was used for a supplementary test. The usual hedonic-scale test was used, except that 2 instead of 3 samples were presented, the glucose-free control and the 2% H_2O glucose-free sample held 18 months at 100° F. The difference in hedonic-scale ratings of the 2 samples under these conditions was 0.8 scale unit, indicating only a relatively slight preference for the control over the sample stored for as long as 18 months at 100° F.

The high proportion of judges who commented adversely on color of scrambled eggs prepared from acidified eggs stored at 100° F. indicates that at this storage temperature color was the most obvious factor influencing preference (Figure 3). The glucose-free egg was unchanged in color at any storage temperature even after 18 months, but the acidified egg showed marked darkening at 100° F. Adverse comments on the development of brown color in the acidified eggs increased markedly at the 3-month test period and continued to increase to such an extent that over half the consumers commented on the color after the acidified eggs were stored for 9 months. Because the 3.5% H_2O acidified eggs browned more rapidly than the 2% H_2O eggs, the high-moisture eggs received more adverse comments on color after 3 months and at all subsequent times. Since there was no development of brown color in the glucose-free eggs there were very few comments on color.

The development of off-flavor in egg solids stored at 100° F. was not paralleled by an increase in adverse comments on flavor on the consumer-type tests. This was undoubtedly due in part to the fact that the most obvious difference between samples stored at 100° F. was the color difference, so that comments on color predominated. Both types of eggs developed off-flavor during storage at 100° F. However, the off-flavor development was considerably more rapid in the acidified than in the glucose-free eggs and in the 3.5% H_2O eggs than in the 2% H_2O eggs (Figure 4). As determined by trained panel dilution tests, acidi-

fied eggs (2% H_2O) stored for only 3 months were distinguished from controls more readily than glucose-free eggs stored for 12 months *(3)*. Thus, flavorwise, equivalent decreases in quality took 4 times as long in the glucose-free powder as in the acidified powder.

The adverse comments showed that the texture of the scrambled acidified eggs was, on the average, more objectionable to

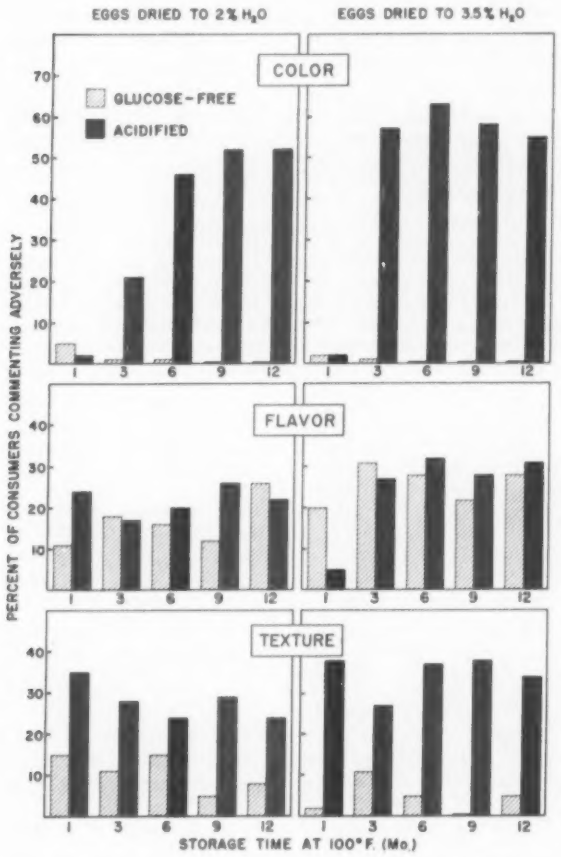


Figure 3. Effect of storage of egg powders at 100° F. on number of adverse comments made on color, flavor, and texture of scrambled eggs.

the test subjects than that of the glucose-free eggs. The same texture characteristics that were present in the scrambled eggs initially were present in eggs prepared from the stored powders, but in the case of the acidified powder, became more pronounced with storage.

The need for including CO_2 in the gas pack as a stabilizing measure was previously shown to be questionable for acidified egg *(1)*, but has generally been included as a precautionary measure and for the practical purpose of preventing bulging of cans at low atmospheric pressure. Present results show that storage of the dried eggs in N_2 or in a mixture of N_2 and CO_2 made no difference in consumer reaction. The paired preference tests showed the same relative preference irrespective of gas packing; the hedonic-scale tests showed that approximately the same score ratings were given to samples packed in N_2 and in the mixture of N_2 and CO_2 (Table 1). Chemical tests and trained panel tests have also shown no difference between samples due to storage atmosphere *(5)*. Addition of CO_2 to N_2 gas packing therefore has demonstrated no benefit in increasing storage stability of acidified or glucose-free powders.

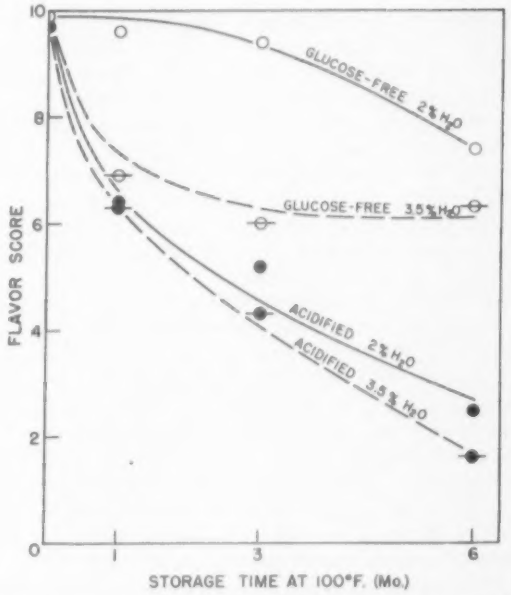


Figure 4. Relative off-flavor development in glucose-free and acidified egg powders as indicated by decrease in flavor score.

Effect of Storage at 40° F. (4.4° C.) and 70° F. (21° C.)

Storage at these lower temperatures resulted in no noticeable color or texture change in either type of egg. At 40° F. no significant development of off-flavor was detected in either powder by the trained panel after 6 months' storage. The trained panel test did, however, show significant storage off-flavor development in the 2% moisture acidified powders stored at 70° F. at both the 6-month and 12-month appraisals and in both types of powder at the 3.5% moisture level after these same storage periods. This off-flavor development at 70° F. was not sufficient, however, to be reflected in the consumer-type tests.

TABLE 1

Consumer test results showing correspondence between judges' reactions to egg solids (2% H_2O) stored in different atmospheres

Storage time at 100° F. (mo.)	N_2 and CO_2	N_2
A. Percentage of consumers preferring glucose-free over acidified eggs		
1	56	70
3	68	69
6	67	69
9	72	75
12	82	82
B. Hedonic-scale values for glucose-free eggs		
3	6.0	5.9
6	6.5	6.2
12	6.3	6.5
C. Hedonic-scale values for acidified eggs		
3	5.6	6.0
6	4.9	5.7
9	4.5	4.5

INTERPRETATION OF CONSUMER-TYPE RESULTS

The results of the hedonic-scale test have been treated as an expression of preference rather than as an indication of the level of acceptability of the various samples. This was done because of evidence indicating that the hedonic rating is, at least under some circumstances,

influenced by the quality of other samples tested previously. There were frequent comments from the participants in the consumer-type tests describing a sample as having more or less of a given characteristic than a previously tested sample. The latter may have been one of the others presented at the same session or in some instances was a sample tested as much as a year previously. Since it is possible that the rating for any given sample could vary considerably with circumstances, there is need for further study of the factors influencing the results of this type of test.

In considering the significance of both consumer preference tests, it is recognized that tests based on expression of opinion from groups of only 40 individuals are only an uncertain estimate of the preference of actual consumers. However, the consistency of both tests in showing a gradually increasing preference for the glucose-free powders during storage at 100° F. together with evidence of the more rapid and greater development of storage off-flavor and the rapid development of browning in acidified powders at 100° F. lends credence to the consumer preference results.

Even though a definition of shelf-life is arbitrary, some basis for shelf-life estimation can be deduced. The investigators feel that color alone would tend to set the shelf-life limit for acidified egg held at 100° F. at about 3 months. Results obtained from the various flavor and chemical tests lead us to believe that shelf-life of glucose-free eggs (at 2% H_2O in N_2) will exceed 18 months at 100° F.

Limited consumer-type tests of glucose-free egg solids prepared by the enzyme process indicate that such eggs have approximately the same acceptability as those prepared by yeast fermentation.

SUMMARY AND CONCLUSIONS

Glucose-free egg solids prepared by the yeast method had an initial acceptability equivalent to or slightly better than that of acidified eggs when compared as scrambled eggs. During storage at 100° F. there was an increasing comparative preference for scrambled eggs prepared from glucose-free powders. This was consistent with the previously demonstrated superior stability of glucose-free whole egg powder. Although both types of eggs developed off-flavor after storage at 100° F., equivalent changes in flavor took 4 times as long in the glucose-free powders as in the acidified powders.

The inclusion of CO_2 in the gas packing mixture has no advantage over straight N_2 pack in increasing the stability of either glucose-free or acidified dried eggs and did not influence relative preference for the two types of eggs.

Increasing the maximum holding time of scrambled eggs after cooking from 20 minutes to 40 minutes increases the preference for glucose-free eggs compared to acidified eggs.

Acknowledgment

The authors acknowledge the assistance of the Quartermaster Food and Container Institute in providing eggs used, in supervising preparation of the acidified eggs, and in planning the consumer-type test. They also acknowledge the assistance of Joyce Anderson, Agnes Campbell, and Kazuko Nishita in preparing and serving the test samples.

LITERATURE CITED

1. Boggs, M. M., and Fevold, H. L. Dehydrated egg powders. Factors in palatability of stored powders. *Ind. Eng. Chem.*, **38**, 1075 (1946).
2. Cochran, W. G., and Cox, G. M. *Experimental Designs.* 1950, John Wiley & Sons, New York, p. 330.
3. Hanson, H. L., Kline, L., and Lineweaver, H. A dilution method for determination of relative flavor stability of eggs. (In press.)
4. Kline, L., Hanson, H. L., Sonoda, T. T., and Gegg, J. E. Role of glucose in the storage deterioration of whole-egg powder. III. Effect of glucose removal before drying on organoleptic, baking, and chemical changes. *Food Technol.*, **5**, 323 (1951).
5. Kline, L., Sonoda, T. T., Hanson, H. L., and Mitchell, J. H. Relative chemical, functional, and organoleptic stabilities of acidified and glucose-free whole egg powders. *Food Technol.*, **7**, 456 (1953).
6. Pervam, D. R., and Girardot, N. F. Advanced taste-test method. *Food Eng.*, **24** (7) 58 (1952).
7. U. S. Quartermaster Corps. Military specification. Stabilized dehydrated egg. QMC Mil-e-10006 (Sept. 12, 1949).

Peanut Butter. VI. The Effect of Roasting on the Palatability of Peanut Butter

NELLE J. MORRIS AND A. F. FREEMAN

Southern Utilization Research Branch,[a] New Orleans, Louisiana

(Manuscript received February 22, 1954)

Peanut butters prepared in the pilot plant from peanuts roasted to various extents were evaluated periodically to determine the effect of extent of roasting accorded the peanuts on flavor characteristics during two years' storage. Taste panel data show that in the opinion of the panel peanut butters from medium roasted peanuts exhibited the most desirable flavor and good flavor retention.

Although peanut buttter is a fairly substantial item in the United States dietary, accounting for the consumption of more than 250 million pounds of shelled peanuts annually, very little definite information can be found in the literature which indicates the effects of conditions of processing upon the product. Roasting is essential in the processing of peanuts for food, in order to remove the taste of raw peanuts and to produce an appetizing product. Pickett has pointed out *(8)* that underroasting or overroasting would be detrimental to the flavor, color, and general desirability of peanut butter.

Previous publications of workers of this Laboratory on this subject have reported on chemical and physical properties of peanut butters prepared in the pilot plant. Data obtained in an investigation of roasting, cooling, blanching and manual sorting of 20 batches of white Spanish peanuts prior to their use in the production of peanut butters have been presented *(11)*. The effects of processing on the thiamine content *(13)* of the resulting peanut butter, on the content of oil and free fatty acids *(7)*, and on the stability of the oil to autoxidative rancidity *(12)* have been described. The colors of peanut butters prepared from peanuts roasted to various extents have been described also *(6)*.

The palatability of peanut butter, as of any food, is the ultimate basis of acceptance. Although objective measurements of quality characteristics may strongly indicate quality in a product, in the final analysis flavor largely determines the acceptability.

The correlation of processing conditions with palatability provides information about the effects of processing on product quality, and hence affords a means of establishing methods of processing leading to improved products. The differences in peanut butters which may be correlated with conditions of processing are differences in appearance and palatability.

The purpose of this work is to provide information about the palatability of peanut butters prepared from peanuts roasted to various extents.

[a] Agricultural Research Service, U. S. Department of Agriculture.

EXPERIMENTAL

Peanuts. The peanuts used in this investigation were No. 1 grade, shelled white Spanish peanuts *(9)* obtained from a commercial shelling plant in southeastern United States.

Processing conditions. The peanuts were roasted in two-bag (250 lb.) batches in a natural gas-fired, radiant-heat roaster *(2)*. The roasted peanuts were cooled, mechanically blanched, and manually sorted to eliminate objectionable material. The blanched, sorted peanuts were ground into peanut butter at the rate of about 240 pounds per hour in an 8-inch, vertical attrition mill of a type used in commercial manufacture of peanut butter. Details of the processing conditions have been reported *(11)* previously, and only sufficient information is repeated to identify the finished product. The wide range in extent of roasting accorded the peanuts is shown by the range of x-trichromatic coordinates (the redness factors) which increase with increase in roasting.

Peanut butters. The peanut butters presented to the organoleptic panel for evaluation contained salt and hydrogenated peanut oil, the latter having been added for the prevention of oil separation. The oil contents of the experimental peanut butters, and details as to their contents of salt and hydrogenated peanut oil have been reported previously by Morris, Willich, and Freeman *(7)* as another part of the investigation of peanut butter. The stability of the oils of these peanut butters has been reported by Willich, Morris, and Freeman *(12)*. The standard samples S-1 and S-2 were commercial peanut butters, and standard sample S-3 was an experimental peanut butter containing virtually the same amounts of salt and oil.

Storage of peanut butters. The peanut butters, packaged in 8-ounce jars provided with lined screw caps, were packed in cartons and stored in a room maintained at approximately 80° F. (26.7° C.).

Panel selection. In organizing the panel 19 persons were ranked on the basis of their percentages of correct judgments in triangular tests *(4)* of medium difficulty using peanut butters as test materials. A panel of 11 persons was selected from those scoring 60% or more correct judgments in 28 or more tests. Several alternate judges were also chosen.

Preparation of samples. At the time of examination the entire contents of an 8-ounce jar of peanut butter were removed, mixed thoroughly to insure uniformity, and placed in small individual milk-glass jars with screw caps.

Evaluation of samples. Four coded samples per session were served at room temperature to the judges who rated them for *color, texture, freedom from rancidity,* and for *palatability*. Colors were described as *excellent, good, fair,* or *unsatisfactory* (definitely pale, dark brown, or off-color for any reason). Texture was evaluated by describing the sample as *not sticky, slightly sticky, moderately sticky,* or *very sticky in the mouth* and as having *excellent, good, fair,* or *poor spreadability* on bread. Information regarding the presence or absence of rancidity was indicated as *not rancid, incipiently rancid,* or *definitely rancid* in odor or taste. Palatability was described as *perfect, excellent, good, fair,* or *unsatisfactory* in odor and flavor.

Numerical ratings were assigned to these adjectival ratings for statistical treatment of the appraisals. The numerical values assigned for color were: *excellent*, 9; *good*, 8; *fair*, 7; and *unsatisfactory*, 3. For texture, *not sticky* was assigned a value of 10; *slightly sticky*, 9; *moderately sticky*, 8; and *very sticky*, 3;

excellent spreadability was assigned a value of 9; *good*, 8; *fair*, 7; and *poor*, 3. Descriptive ratings regarding rancidity were assigned values as follows: *not rancid*, 10; *incipiently rancid*, 7; and *definitely rancid*, 3. For palatability, values were assigned as follows: *perfect*, 10; *excellent*, 9; *good*, 8; *fair*, 7; and *unsatisfactory*, 3.

The statistical plan used for the appraisals reported in Table 3 was the balanced incomplete block design *(3)*. The statistical analysis was that outlined for the particular design used. Appraisals in a preliminary screening of the samples were not treated for analysis of variance.

RESULTS AND DISCUSSION

In Tables 1, 2, and 3 the batches are arranged in an ascending order according to the extent of roast from the lightest to the heaviest as indicated by color measurements obtained *(6)* by a spectral reflectance method. The *x*-trichromatic coordinates (the redness factors), which are included in Table 1 and which constitute objective indices of the extent of roasting, are reproduced here from data of Morris, Lohmann, O'Connor, and Freeman previously reported *(6)*. According to the United States Standards for Grades of Peanut Butter *(10)*, "light roast" means that the color is not darker than Plate 11, G-6 as illustrated in Maerz and Paul's "Dictionary of Color" *(5), and "heavy roast"* means that the color is darker than Plate 11, G-6.

The colors of peanut butters made from "heavy" roasted peanuts were considered (Table 1) by the panel to be *good* with the exception of Batches 2 and 4, the lightest of the batches classified as "heavy roast." These 2 batches together with Batches 1, 3 (which were obviously underroasted), and 6, classified as "light roast," were considered only *fair*. Standards S-1 and S-2 were considered by the panel to be "light roasts" and only *fair* in color.

The panel found little difference in stickiness (Table 1) of peanut butters (in the mouth) regardless of the extent of roasting accorded the peanuts, describing all samples as *moderately sticky*. The judgment of the panel regarding the spreadability of the samples was *good* or *excellent*, the tendency being for the peanut butters from the lighter roasted peanuts to receive the *excellent* ratings.

Samples from Batches 2-19, inclusive, were rated by the panel for the presence or absence of rancidity at the time of preparation and periodically throughout a period of storage of two years at 80° F. The ratings assigned by the panel indicated that rancidity was not detected organoleptically throughout the 2 years the experiment was in progress. This finding is supported by chemical determination of the stabilities of the oils of these peanut butters. The stability of these oils toward autoxidative rancidity was found *(12)* to be quite high at the time of manufacture of the peanut butters, and to remain satisfactorily high (although somewhat reduced) even after storage of the peanut butters at 80° F. in the absence of light for 2 years. It has been pointed out that the development of free fatty acids and of rancidity in a fat are not related *(1)*. In this connection, it may be of interest that the free fatty acid contents of the oils of the experimental peanut butters, for which organoleptic data are given in this report, were uniformly low (ca. 0.2%), at the time of manufacture *(7)*. It has also been found that the free fatty acid contents of the oils did not change appreciably during the storage of the peanut butters throughout the period of storage of 2 years, whereas some reduction in stability of the oils was observed.

Table 2 presents ratings for palatability throughout a storage period of 2 years. These data indicated high

TABLE 1

Properties of peanut butters made from variously roasted peanuts

Batch [1]	Processing information			Color of peanut butter		Panel evaluation		
	Roasting time	Roasting temp.		Extent of roast [2]	*x*-Trichromatic coordinates [3]	Texture		Color
		Minimum	Maximum			Stickiness	Spreadability	
	min.	*° F.*	*° F.*					
1	17	230	275	light	0.3634	.....	.....	.....
3	21	205	285	light	0.3824	moderate	excellent	fair
6	25	200	292	light	0.3873	moderate	excellent	fair
2	23	205	283	heavy	0.3914	moderate	excellent	fair
4	22	200	285	heavy	0.3916	moderate	excellent	fair
5	21½	205	285	heavy	0.3958	moderate	excellent	good
9	26	200	298	heavy	0.3987	moderate	good	good
7	22½	200	290	heavy	0.4051	moderate	good	good
11	23	215	295	heavy	0.4052	moderate	good	good
14	29	260	304	heavy	0.4135	moderate	good	good
12	26	200	308	heavy	0.4149	moderate	good	good
15	24	210	300	heavy	0.4154	moderate	good	good
10	24	200	300	heavy	0.4162	moderate	good	good
13	25	205	309	heavy	0.4164	moderate	good	good
8	21	210	290	heavy	0.4168	moderate	excellent	good
16	25	205	305	heavy	0.4215	moderate	good	good
17	20	240	305	heavy	0.4257	moderate	excellent	good
18	21	215	315	heavy	0.4299	moderate	good	good
19	17¾	250	320	heavy	0.4374	moderate	good	good
S-1 [4]	.....	.....	.....	.....	.....	moderate	good	fair
S-2	.....	.....	.....	.....	.....	moderate	excellent	fair
S-3	32	195	302	heavy	.....	moderate	good	good

[1] Batches are arranged in ascending order according to extent of roast from the lightest to the heaviest as indicated by their *x*-trichromatic coordinates.
[2] "Light" means that the color was not darker than Plate 11, G-6 of Maerz and Paul's "Dictionary of Color" and "heavy" means that the color was darker than Plate 11, G-6.
[3] Standard samples S-1 and S-2 were fresh commercial peanut butters and standard S-3 was an experimental peanut butter less than 6 months old.

TABLE 2

Palatability ratings[1] for peanut butters

Batch	Extent of roast	Appraisal after storage at 80° F., months				
		0	1-6	7-12	13-18	19-24
3	light	.....	.....	good—	unsatisfactory	.....
6	light	good+	good+	good—	unsatisfactory	unsatisfactory
4	heavy	.....	.....	good—	unsatisfactory	.....
5	heavy	.....	.....	.....	good—	unsatisfactory
9	heavy	excellent—	good	good+	unsatisfactory	fair
11	heavy	.....	.....	.....	good—	good—
14	heavy	good+	.....	good	good—	good—
12	heavy	excellent—	excellent—	good+	good—	good—
15	heavy	.....	.....	good	fair+	good—
10	heavy	good+	excellent—	good+	good—	good—
13	heavy	.....	good	.....	good—	good—
16	heavy	.....	good—	good+	fair+	fair+
17	heavy	.....	.....	good—	fair+	unsatisfactory
18	heavy	.....	.....	.....	good—	unsatisfactory
19	heavy	.....	.....	.....	.....	unsatisfactory

[1] These appraisals are the means of several replicates rated adjectively by a panel of 11 persons, except for the ratings before storage which are the means of two replicates by 6 persons. These adjectives had been assigned numerical values: A rating of *perfect* denoted a score of 10; *excellent*, 9; *good*, 8; *fair*, 7; and *less than fair*, 3. In the above table, e.g., *good*+ denotes that the mean lay between 8.1 and 8.4, and *good*— denotes that the mean lay between 7.5 and 7.9.

acceptance by the panel for the peanut butter samples near the middle of the list of batches in the table. This is particularly noticeable in the ratings for peanut butters after storage for more than a year, and seems to indicate that these samples retain their desirable flavor longer than the samples made from peanuts of lighter or heavier roasts. Samples from Batches 10, 11, 12, 13, 14, and 15 (heavy roast) received ratings of *good*— or better, with the exception of one score of *fair*+ for Batch 15, throughout the 2-year period of storage. Samples from Batches 3, 4, 5, 6, and 9 (lighter), and samples from Batches 16, 17, 18, and 19 (heavier) received *fair*+, *fair* or *unsatisfactory* ratings, with the exception of one rating of *good*— for Batch 5 and one rating of *good*— for Batch 18, after a year of storage.

Table 3 shows the results obtained upon further evaluation of samples from 10 batches. The peanut butters from peanuts obviously roasted too little to produce good flavor characteristics and those from definitely overroasted peanuts were excluded. Batches 4 and 5, which the panel had rated as *unsatisfactory* (4 replications with 11 persons on the panel), were also excluded from further evaluation.

In Experiment 1 (Table 3) the samples were compared with each other without a standard. In Experiment 2, standards S-1 and S-2 were fresh commercial peanut butters, and standard S-3 was an experimental peanut butter less than 6 months old. In Experiment 3, standard S-1 was a fresh commercial peanut butter.

Significantly higher scores (Table 3, Experiment 1) were given samples from Batches 10, 11, 12, 13, 14, and 15 than were given the peanut butters from lighter roasted peanuts (Batches 6 and 9), or given the peanut butters from the heaviest roasted peanuts (samples from Batch 17).

In Experiment 2 (Table 3), significantly higher scores were given samples from Batches 10, 12, and 14 than were given the sample from Batch 6 (light roast).

In Experiment 3 (Table 3), significantly higher scores were given samples from Batches 10, 12, and 16 than were given the sample from Batch 6 (light roast).

The three peanut butters (Batches 10, 12, and 14) which consistently received the highest scores (Tables 2 and 3) throughout 24 months of storage at 80° F. were very close together in extent of roast as indicated by their x-trichromatic coordinates. The x-trichromatic coordinates, which constitute objective indices of the extent of roasting, were (Table 1) 0.4162, 0.4149 and 0.4135 for Batches 10, 12, and 14, respectively.

It is noteworthy that the palatability scores for the samples from all batches except Batches 6 and 9 (lighter roasts) and Batch 17 (heaviest roast) compare favorably with the scores for the standard samples which had had normal commercial storage in the case of standards S-1 and S-2, and storage for less than 6 months at 80° F. in the case of standard S-3.

It may be concluded from organoleptic data on stored peanut butters prepared from variously roasted peanuts that the peanut butters made from medium roasted peanuts embodied the most desirable flavor in the opinion of the panel and retained desirable flavor longer than the samples from peanuts of lighter or heavier

TABLE 3

Mean palatability scores[1] for peanut butters

Batch	Extent of roast	Experiment 1	Experiment 2	Experiment 3
		Storage at 80° F., 14-24 months	Storage at 80° F., 18-24 months	Storage at 80° F., 21-26 months
6	light	6.4	6.8	6.7
9	heavy	6.8	7.2	6.9
11	heavy	7.7	.....	.....
14	heavy	8.0	7.9	7.3
12	heavy	7.8	8.0	7.5
15	heavy	7.8	.....	.....
10	heavy	7.8	7.6	7.8
13	heavy	7.9	7.3	.....
16	heavy	7.5	7.4	7.5
17	heavy	6.9	.....	.....
S-1[2]	.....	.....	7.0	7.4
S-2[2]	.....	.....	7.3	.....
S-3[2]	.....	.....	7.1	.....
L.S.D.[3] at 5% level		0.6	0.8	0.8
L.S.D. at 1% level		0.8	1.0	1.1

[1] For experiments 1 and 2 the scores are the means of six replicates scored by eleven judges; for experiment 3 the scores are the mean of ten replicates scored by eleven judges. A score of 10 denotes *perfect*; 9, *excellent*; 8, *good*; 7, *fair*; 3, *unsatisfactory*.

[2] Standards S-1 and S-2 were fresh, commercial peanut butters which the panel rated of "fair" color; standard S-3 was an experimental peanut butter (less than six months old) which the panel rated of "good" color.

[3] L.S.D. indicates the least difference between scores which is significant at the stated level of probability.

roasts. It does not necessarily follow that large consumer panels would prefer exactly the same roast. These data indicate that careful control of roasting of the peanuts is necessary for the production of peanut butter of the most desirable flavor and good flavor retention.

SUMMARY

Peanut butters prepared in a pilot plant at the Southern Regional Research Laboratory from No. 1 grade, white Spanish peanuts, roasted to various extents from underroasted to overroasted, were evaluated periodically by an organoleptic panel throughout a period of storage of two years at 80° F. It may be concluded from the organoleptic data that in the opinion of the panel the peanut butters prepared from medium roasted peanuts embodied the most desirable flavor and retained desirable flavor longer than peanut butters from lighter or heavier roasted peanuts. Large consumer panels might not prefer exactly the same roast. However, the data indicate that careful control of roasting is necessary for the production of peanut butter of the most desirable flavor and good flavor retention.

Acknowledgment

The authors wish to express their appreciation to numerous employees of the Southern Regional Research Laboratory who served as judges in the organoleptic evaluation.

LITERATURE CITED

1. Bailey, A. E. *Industrial Oil and Fat Products.* 1945, Interscience Publishers, Inc., New York, N. Y., p. 44.
2. Beattie, W. R. Making and using peanut butter. U. S. Dept. Agr., *Circ., 384* Rev. (1941).
3. Cochran, W. G., and Cox, G. M. *Experimental Design.* 1950, John Wiley & Sons, Inc., New York City. (Chapter 11).
4. Helm, E., and Trolle, B. Selection of a taste panel. *Wallerstein Labs. Commun.*, **9**, 181 (1946).
5. Maerz, A., and Paul, M. R. *A Dictionary of Color.* 1930, McGraw-Hill Book Co., New York, N. Y.
6. Morris, N. J., Lohmann, I. W., O'Connor, R. T., and Freeman, A. F. Peanut Butter. IV. Determination of color of peanut butter by a spectral reflectance method. *Food Technol.*, **7**, 393 (1953).
7. Morris, N. J., Willich, R. K., and Freeman, A. F. Peanut Butter. III. Effect of roasting, blanching and sorting on the content of oil and free fatty acids of peanuts. *Food Technol.*, **7**, 366 (1953).
8. Pickett, T. A. Thiamin Content of Peanut Butter. Ga. Expt. Sta. *Circ. 146,* August 1944.
9. Southeastern Peanut Association, Americus, Georgia. Official Rules of Southeastern Peanut Association. Adopted and revised June 20, 1950.
10. United States Department of Agriculture, Production and Marketing Administration. United States Standards for Grades of Peanut Butter (Effective September 1, 1942).
11. Willich, R. K., Hall, A. S., Morris, N. J., and Freeman, A. F. Peanut butter. I. Roasting, cooling, blanching, and picking of peanuts. *Food Technol.*, **6**, 71 (1952).
12. Willich, R. K., Morris, N. J., and Freeman, A. F. Peanut butter. V. The effect of processing and storage of peanut butters on the stabilities of their oils. *Food Technol.*, **8**, 101 (1954).
13. Willich, R. K., Murray, M. D., O'Connor, R. T., and Freeman, A. F. Peanut butter. II. Effect of roasting and blanching on the thiamine content of peanut butter. *Food Technol.*, **6**, 199 (1952).

Peanut Butter. VIII. Effects of Processing and Storage on Vitamin A Incorporated in Peanut Butter

R. K. WILLICH, N. J. MORRIS, R. T. O'CONNOR, AND A. F. FREEMAN
Southern Utilization Research Branch,[a] New Orleans, Louisiana

(Manuscript received March 22, 1954)

The effects of processing temperatures and conditions of storage on the vitamin A palmitate incorporated in peanut butter have been investigated. While no significant losses could be attributed to temperature only, a definite but small loss in vitamin A may be ascribed to the inclusion of atmospheric oxygen, and to frictional heat produced in the manufacture of the product. The content of vitamin A incorporated in peanut butter was found to remain satisfactorily high, although reduced, after storage of the product for six months at either 80, or 100° F.

Vitamin A or its esters derived from natural sources has been used for many years in fortifying food products normally deficient in this material. For example, fortification of margarine with vitamin A has become standard industrial practice. That peanut butter has been overlooked in this regard is surprising, particularly in view of the size of the industry. No information can be found in the literature with respect to the effects of processing on the vitamin A content of the fortified product. It would appear that fortification of peanut butter would present no particular problem. Indeed, recent work at the Southern Utilization Research Branch *(12)* has described equipment for a continuous process for manufacture of peanut butter fortified with vitamin A.

Although the method for synthesizing vitamin A has been known for over a decade the synthetic product has been available in commercial quantities only in recent years *(9)*. The synthetic product has been found to have the same biological equivalent *(5)* and stability *(2)* as the natural vitamin A, but has none of the taste or smell of fish oil which has never been removed from vitamin A derived from natural sources regardless of the manner of processing *(5)*.

Vitamin A, though stable to heat in an inert atmosphere *(1)*, is destroyed by ultraviolet light and is sensitive to atmospheric oxygen. It has been shown *(4)* that increase in peroxide value of an oil rich in natural vitamin A was accompanied by destruction of the vitamin. It has also been demonstrated *(11)* that vitamin A (dissolved in fat) had a very high percentage of survival (80-100%) when incorporated in bread, biscuits, and cake baked at temperatures of from 360-425° F. for 20-40 minutes, but that substantial losses in vitamin A content were encountered in baked pie crust of relatively high oil content. The losses were found to be proportional to the baking time at 425° F.

Because of the destruction of vitamin A occasioned by fat peroxides, various investigations have been conducted to determine the effects of antioxidants in reducing the amount of destruction. Using the "AOM" stability technique, Dassow and Stansby were able to correlate *(3)* increase in fat peroxides with destruction of vitamin A. Their findings showed that, although the presence of an antioxidant such as nordihydroguaiaretic acid (NDGA) was effective in reducing the extent of vitamin A destruction, the effectiveness of the antioxidant was appreciably enhanced by the addition of citric acid as a synergist. The permissible amount of NDGA (0.01%) together with citric acid (0.005%) in fats has been established *(10)* by the United States Department of Agriculture.

The work *(2)* of Bauernfeind, Rokosny, and Siemers using margarine fortified with a synthetic vitamin A ester incorporated in standard type cakes and cookies indicated no substantial reduction in synthetic vitamin A ester content when the products were baked at 375-400° F. Furthermore, their work showed no substantial changes in content of vitamin A palmitate occasioned by heat when the vitamin was added to freshly prepared peanut butter at a temperature of 140° F. In addition, they found no change in vitamin A content of the fortified peanut butter upon storage of the product for 1000 hours at 113° F.

The purpose of this work is to provide information regarding effects of processing and storage on the vitamin A content of fortified peanut butter.

EXPERIMENTAL

Peanuts. Two hundred and fifty pound batches each, of No. 1 grade, shelled, runner peanuts were roasted. The roasted peanuts were split-blanched mechanically, and manually sorted. Details of these operations have been reported *(13)* in a previous publication. Only the manually sorted peanuts were used in the preparation of peanut butter.

Additives. All of the peanut butters prepared contained hydrogenated peanut oil,[b] salt, and peanut oil[c] as a carrier for the vitamin A. The materials were delivered to the grinder during peanut butter manufacture by means of special feeders. Details of these feeders and of the preliminary treatment accorded the hard fat and salt have been reported *(12)* in a previous publication.

Preparation of vitamin A solutions. A known amount of synthetic vitamin A palmitate was dissolved in peanut oil whose initial peroxide value was 0. Vitamin A was added to the peanut oil in an amount calculated to insure at least 71 U.S.P. units of vitamin A per g. of peanut butter and to allow for a possible loss

[a] Agricultural Research Service, United States Department of Agriculture.

[b] A commercial grade of hydrogenated peanut oil [ca. M.P. 64.5° (148° F.) and iodine value ca. 5-8].

[c] A commercial grade of peanut oil free of peroxides.

of vitamin A in processing and storage of the peanut butter. The computation was based on incorporation of the fortified peanut oil, so that the peanut butter would contain about 84 U.S.P. units of vitamin A per g.

Analyses of the vitamin A solutions used in Experiment No. 1 and in Experiment No. 2 indicated the presence of 8730, and 8800 U.S.P. units of vitamin A per g., respectively. In Experiment No. 3 NDGA (0.53%) as an antioxidant and citric acid [4] (0.29%) as a synergist were added to a portion of the vitamin A solution, which was found to contain 8640 U.S.P. units of vitamin A per g.

Peanut butter preparation. Three batches (Experiment Nos. 1, 2, and 3) of the manually sorted peanuts were ground into peanut butter along with the additives at a rate of about 247 lbs. of peanut butter per hour. The feeders were adjusted to produce peanut butter containing 84 U.S.P. units per g. of vitamin A as well as 2% of hydrogenated peanut oil and 1.5% of salt. A small quantity (ca. 15 lbs.) of non-fortified peanut butter was prepared in each experiment for use as a basis of comparison in the vitamin A analysis.

In Experiment No. 1 samples of the peanut butter were collected every 3 minutes as the product issued from the grinder over a half hour period, beginning 10 minutes after the start of grinding.

In Experiment No. 2 the peanut butter issuing from the grinder was allowed to fall into, and circulate within an open-head heating device equipped with a heat exchanger. By this means, the temperature (140° F.) resulting from grinding of peanuts and other additives into peanut butter was increased by about 20° F. in one operation, and by about 40° F. in the succeeding operation. Samples of the fortified peanut butter were taken (in 8-ounce glass jars) at temperatures of about 140°, 160°, and 180° F. directly after the heating equipment was filled. The contents of the sample jars were allowed to reach room temperature naturally. In order to obtain peanut butter samples as uniform as possible in composition, only the portion that issued from the grinder after grinding had been in progress for 17 minutes was sampled.

In Experiment No. 3 about one-half of the peanut butter prepared contained antioxidant and synergist in addition to vitamin A. Grinding of the peanuts was stopped long enough to change from the peanut oil solution containing no added antioxidant and synergist to the solution containing these materials as well as vitamin A. Peanut butter prepared during the course of the experiment was packaged in 8-ounce screw-cap jars using a semi-automatic filling machine. The jars were filled to capacity leaving no headspace for air over the peanut butter. Both types of peanut butter prepared in this experiment were placed in cardboard cartons, some of which were kept in a room maintained at 80° F., and others in a box maintained at 100° F. Also, peanut butter which contained no vitamin A and antioxidant was stored similarly.

Sampling and analysis. Fortified peanut oils were analyzed for vitamin A content just prior to the incorporation of the oil in peanut butter.

The freshly prepared peanut butters were analyzed for vitamin A content. In Experiment No. 3, two samples, selected at random every 2 months during storage of the peanut butters at 80° and 100° F., were analyzed for vitamin A content and AOM [5] stabilities of the oils.

Methods of analysis. The vitamin A content of the peanut oils from peanut butter samples was determined by a modification of the ultra-violet-absorption method of the Association of Vitamin Chemists *(1)*. The modification, which has been previously described *(8)*, takes advantage of the fact that an exact control can be made available for each sample. Extraneous absorption at 325 mμ, the position of maximum absorption of vitamin A in isopropanol solution, is obtained by measurement of the control containing no added vitamin A, thus avoiding the rather unsatisfactory Morton-Stubbs mathematical correction *(7)*. Controls were obtained by subjecting portions of unfortified sample to exactly the same processing and storage conditions as were the samples containing the added vitamin. This means of evaluation neglects only a possible additional extraneous absorption arising from oxidation products upon destruction of the vitamin A. At the level of vitamin A destruction encountered in these experiments, this is a negligible factor.

The stabilities of the oils extracted from fortified peanut butters were determined by the active oxygen method (AOM) at 97.8° C. Use of this method in determining the stabilities of oils extracted from peanut butters has been described *(6, 14)* previously.

[4] U.S.P. grade (hydrated), which was ground and passed through a No. 325 mesh sieve, U. S. Std. series.

[5] AOM (hours) refers to the stability of the oils expressed as the number of hours required by the oil to accumulate 100 meq. of peroxides per kg. during aeration at 97.8° C. and an air-flow of 2.33 ml./sec.

RESULTS AND DISCUSSION

The accuracy of the method for determining the content of vitamin A incorporated in peanut butter was ascertained by a series of analyses on two samples of peanut butter fortified with vitamin A. About 85 U.S.P. units of synthetic vitamin A palmitate per g. were incorporated manually in unfortified peanut butter at about 75° F. using a specially constructed grease worker. Data (Table 1) indicate that all of the vitamin A calculated to have been incorporated in a small amount of peanut butter at room temperature was recovered on analysis.

TABLE 1

Determination of vitamin A incorporated in peanut butter at 75° F.

Vitamin A analyses of peanut butters	
Sample No. 1 U.S.P. units per gram	Sample No. 2 U.S.P. units per gram
86	86
85	86
84	87
Average 85	86
Recovery [1] 100%	101%

[1] Computed on the basis of the amount of vitamin A contained in the peanut oil known to have been incorporated in the peanut butter. The fortified peanut oil comprised 1% by weight of the peanut butter, and the potency of the fortified oil was 8460 U.S.P. units of vitamin A per gram.

Experiment 1. *Uniformity of addition of vitamin A.* Table 2 shows the vitamin A contents determined on a series of fortified peanut butters taken at regular intervals after constant operating conditions had been

TABLE 2

Experiment 1. Uniformity of incorporation of vitamin A [1] in peanut butter

Sample No.	Mill in operation	Temp. of peanut butter	Vitamin A
	minutes	*° F.*	*U.S.P. units/g.*
1	10	138	74
2	13	140	76
3	16	141	80
4	19	142	78
5	22	143	79
6	25	143	77
7	28	143	78
8	31	143	78
9	34	143	83
10	37	144	77
11	40	144	75
			Av. 78

[1] Average of duplicate analyses.

reached. Data obtained in preliminary work showed that within the first 10-15 minutes of grinding, considerable variation in vitamin A content occurred coincident with the usual rapid rise in temperature of the peanut butter. The temperature of the peanut butter issuing from the grinder was recorded continuously. The average of the vitamin A contents (78 U.S.P. units per g.) of the samples taken, starting after ten minutes of grinding, was found to be 7% less than the one (84 U.S.P. units per g.) computed for the fortified product, taking into account all ingredients.

Experiment 2. *Effect of heat.* Data shown in Table 3 indicate that heating at 180° F. occasioned little loss in the vitamin A content of the resulting peanut butter over that occasioned by heating at 140° F. or 160° F.

TABLE 3

Experiment 2. Vitamin A content [1] of peanut butter heated to various temperatures

Temp.	ca. 140° F.		ca. 160° F.		ca. 180° F.
No.	Vitamin A	No.	Vitamin A	No.	Vitamin A
	U.S.P. units/g.		*U.S.P. units/g.*		*U.S.P. units/g.*
1	79	7	82	13	77
2	79	8	79	14	82
3	—	9	79	15	78
4	81	10	80	16	77
5	80	11	80	17	77
6	81	12	82	18	78
Av.	80	Av.	80	Av.	78

[1] Average of duplicate analyses.

The content of the vitamin A in the peanut butter heated at 160° F. was found to be 80 U.S.P. units per g., a decrease of 4 U.S.P. units, or 5% on the basis of the amount of vitamin A incorporated in the product. Correspondingly, the peanut butter heated at 180° F. was found to contain 78 U.S.P. units per g., a decrease of 6 U.S.P. units, or 7% on the basis of the vitamin incorporated in the product.

These findings and general knowledge about the properties of vitamin A support a conclusion that the losses in vitamin A may be ascribed to inclusion of atmospheric oxygen and to frictional heat produced in the manufacture of the product.

Experiment 3. *Effect of storage.* Analyses of freshly prepared peanut butters showed that the vitamin A contents were within the range of 74-83 U.S.P. units per g.

Analyses of freshly prepared samples of peanut butters and of samples taken every 2 months during storage showed (Table 4) in most instances that the vitamin A contents were still within the range of vitamin A contents resulting after manufacture. In one case, however (Table 4, column 2), the vitamin A contents were somewhat less than might have been expected; in this

TABLE 4

Experiment 3. Vitamin A [1] content of fortified peanut butters during storage

Days	Time and Temperature of Storage			
	80° F.		100° F.	
	Without antioxidant	With antioxidant [2]	Without antioxidant	With antioxidant [2]
	U.S.P. units/gram			
0 [3]	76	79	76	79
65	68½	74	75	75½
123	72	74	74	77½
180	67	73½	72	75½

[1] Averages of duplicate analyses of duplicate samples.
[2] Contains 0.005% NDGA in addition to 0.0025% (anhydrous basis) of citric acid.
[3] Freshly prepared peanut butter.

instance, the loss of vitamin A occasioned by storage of the peanut butter containing no added antioxidant for 180 days at 80° F. was found to be 9 U.S.P. units per g. of peanut butter, or 12% on the basis of the vitamin A content before storage. However, in all cases, regardless of time or temperature of storage, the vitamin A content per 1½ oz.[f] of peanut butter was found to be more than sufficient to supply one-half the daily recommended amount for an adult. Although the results indicate that the vitamin A contents of the samples containing NDGA and citric acid were slightly higher than those of the control samples, no strong evidence was obtained of any appreciable benefit from use of these substances.

Results (Table 5) of A.O.M. stabilities determined on the oils extracted from vitamin A fortified peanut butters at times corresponding to the times of vitamin A analyses indicate a gradual decrease in stability from about 58 A.O.M. hours at the beginning of storage to about 37 A.O.M. hours after storage of the peanut butters for 6 months. Approximately the same gradual decrease in stability occurred regardless of whether the peanut butters contained added antioxidant and syner-

[f] The amount of peanut butter supplied in the Army field ration.

TABLE 5

Stability of oil of stored peanut butter

Storage period	Storage at 80° F.				Storage at 100° F.			
	Without antioxidant		With antioxidant		Without antioxidant		With antioxidant	
	I.P.V. [1]	AOM [2]	I.P.V.	AOM	I.P.V.	AOM	I.P.V.	AOM
months		*hrs.*		*hrs.*		*hrs.*		*hrs.*
0	0	59	0	56	0	59	0	56
2½	2	49	1	54½	2	48	1	49
4	1½	36½	0	43½	0	42	0	46
6	2	37½	2½	39	2	38½	6	34½

[1] I.P.V. refers to the initial peroxide value of the oil before heating and aeration expressed as the milliequivalents of peroxides per kg. of oil.
[2] AOM (hours) refers to the stability of the oils expressed as the number of hours required by the oil to accumulate 100 milliequivalents of peroxides per kilogram during aeration at 97.8° C. with an air flow of 2.33 ml./sec.

gist, and regardless of the temperature (80° F. or 100° F.) of storage.

SUMMARY

The effects of processing and conditions of storage on the content of vitamin A incorporated in peanut butter have been investigated. In the continuous manufacture of vitamin A fortified peanut butter, about 93-95% of the vitamin A added during manufacture was found to be retained in the finished product. Loss in vitamin A content may be ascribed to frictional heat and inclusion of atmospheric oxygen in the peanut butter during grinding.

Differences in temperature of processing, 140-180° F., were not found to have an appreciable effect upon the content of vitamin, although the loss of vitamin was slightly greater when the temperature of processing was about 180° F. than when it was in the range of 140-160° F.

During storage of the peanut butters the vitamin A content remained satisfactorily high, although some loss occurred after 180 days at 80° F. or 100° F. Although the vitamin A contents of samples which contained an antioxidant, NDGA, and a synergist, citric acid, were slightly higher than those of the control samples, no strong evidence was obtained of any appreciable benefit from use of these substances.

Acknowledgment

Acknowledgment is made to Mildred G. Murray, and to Dorothy C. Heinzelman for vitamin A analyses of peanut oils and peanut butters; and to the Chas. Pfizer & Company, Inc., New York, N. Y., for furnishing the synthetic vitamin A palmitate used in the experiments.

LITERATURE CITED

1. Association of Vitamin Chemists, Inc. *Methods of Vitamin Assay.* 2nd Ed., 1951, Interscience Publishers, Inc., New York, N. Y.
2. Bauernfeind, J. C., Rokosny, Ann D., and Siemers, G. F. Synthetic vitamin A aids food fortification. *Food Eng.*, **25**, 81 (1953).
3. Dassow, J. A., and Stansby, Maurice E. Stabilization of vitamin A in halibut liver oil with nordihydroguaiaretic acid (NDGA). *J. Am. Oil Chem. Soc.*, **26**, 475 (1949).
4. Hilditch, T. P. Some factors affecting the control of oxidative rancidity. *Chemistry and Industry*, **8**, 67 (1944).
5. Leighton, A. E. How to vitaminize candies. Part I. *Food Eng.*, **23**, 104 (1951).
6. Morris, Nelle J., and Freeman, A. F. Determination of stabilities of crude peanut oils by accelerated aeration methods. *Food Technol.*, **7**, 227 (1953).
7. Morton, R. A., and Stubbs, A. L. Photoelectric spectrophotometry applied to the analysis of mixtures and vitamin A oils. *Analyst*, **71**, 348 (1946); A re-examination of halibut-liver oil. Relation between biological potency and ultraviolet absorption due to vitamin A. *Biochem. J.*, **41**, 525 (1947); Studies in vitamin A. 4. Spectrophotometric determination of vitamin A in liver oils. Correction for irrelevant absorption. *Biochem. J.*, **42**, 195 (1948).
8. Murray, Mildred D., O'Connor, Robert T., Suarez, C. Carlos, and Bickford, W. G. Sesame Oil. X. The stability of vitamin A in sesame oil. *J. Am. Oil Chem. Soc.*, **30**, 329 (1953).
9. O'Connor, Joseph A. Synthetic vitamin A. *Chem. Eng.*, **57**, 146 (1950).
10. *Regulations Governing the Meat Inspection of the United States Department of Agriculture.* 1952, Sec. 18.7 (d) (6) 93, U. S. Government Printing Office, Washington, D. C.
11. Rice, E. E., Black, H. C., Carlin, G. T., and Robinson, H. E. Vitamin A added to fats as related to stability during baking. *Oil & Soap*, **19**, 164 (1942).
12. Willich, R. K., and Freeman, A. F. Peanut butter. VII. Equipment for incorporating vitamin A in the manufacture of peanut butter. (In manuscript).
13. Willich, R. K., Hall, A. S., Morris, N. J., and Freeman, A. F. Peanut Butter. I. Roasting, cooling, blanching and picking of peanuts. *Food Technol.*, **6**, 71 (1952).
14. Willich, R. K., Morris, N. J., and Freeman, A. F. Peanut Butter. V. The effect of processing and storage of peanut butters on the stabilities of their oils. *Food Technol.*, **8**, 101 (1954).

Notes and Letters

Cost of Radiation Sterilization Applied to Food in Tin Plate Containers

TO THE EDITOR:

This letter is being written to correct a general misconception we fear may arise from Dr. R. F. Robinson's article on radiation sterilization in the April issue of FOOD TECHNOLOGY.

The source of our concern is Dr. Robinson's statement, "Food containers for use in cold sterilization should be made of low-density materials and be as thin as possible. The cost of sterilizing a material packaged in steel, which is very opaque to these radiations would be considerably greater than the cost of sterilizing the same quantity of food in an aluminum container, which more readily transmits x-rays or electrons."

To us, the available evidence suggests instead that with gamma radiation from radioactive isotopes and with cathode radiation (electrons) from a Van de Graaf generator, at least, the cost of sterilizing a food product in a conventional tin plate container would *not* be appreciably greater than the cost of sterilizing in an aluminum container.

Let us compare containers of 85 lbs. per base box tin plate and of .010 inch thick aluminum sheet. These containers are comparable in thickness, but it is only fair to note in passing that the tin plate is far stronger.

Irradiating 103 high sardine cans of unit density product from two sides using cathode radiation from a Van de Graaf type accelerator, 3,000,000 volts are required to achieve the theoretical optimum efficiency of 77% of the cathode ray output. Of the 23% lost, 14% is absorbed in the tin plate and 9% is expended in localized overdose of the product.

Irradiating aluminum sardine cans of the same size, 2,600,000 volts are required to achieve the theoretical optimum efficiency of 75% of the cathode ray output. Of the 25% lost, 5% is absorbed in the aluminum and 20% is expended in localized overdose of the product.

Thus, although a lower voltage is possible using an aluminum container, the power costs would even be slightly lower with a tin plate container if we can assume equal costs per kilowatt hour output at the two voltages.

As cathode ray accelerators of other types become available with sufficient voltage to penetrate commercial sized cans, the different absorption characteristics of their radiations will require separate comparison of container materials.

If, for simplicity of geometry, we assume a point source of 1 Mev gamma radiation located several inches from a tin plate can, about one percent of the radiation reaching the contents will be absorbed in the tin plate. In the case of an aluminum can about half this would be absorbed, but the possible saving with an aluminum can appears trivial using a radioactive isotope source.

The situation with soft x-rays is quite different from that with gamma or cathode radiation. The soft x-rays are so readily absorbed that the thickness of the container is relatively critical and even the one hundredth inch thick aluminum container would transmit only about 20% of 100 kv. (peak) or 6% of 15 kv. (peak) x-rays. The transmission through tin plate, of course, would be only a fraction of this amount.

G. B. PRATT
Container Utilization Section
American Can Company
Chicago, Illinois

A Rapid Test for Distinguishing Between Butter Fat and Fats from Plant and Other Animal Sources

The following account describes a rapid color test which can be used to distinguish between butter fat and other plant and animal fats commonly used in foodstuffs. The test is based on the hydroxamic acid test described by Feigl *(2)* and developed as an analytical method for determination of various esters by Lipmann and Tuttle *(5)*, Hestrin *(3)*, Hill *(4)*, Buckles and Thelen *(1)* and Thompson *(6)*.

The specific test to be described takes into account the fact that fats derived from milk (cows, goats, sheep, etc.) will form water soluble hydroxamic acid-iron complexes from short chain fatty esters contained in the fats. These complexes appear as a pink to purple color in the water layer. The hydroxamic acid-iron complexes formed from the fatty acid esters in plant fats (except for coconut and similar species) and other animal fats are insoluble in water and do not contribute a distinctive pink to purple color to the water layer. It is this distinctive appearance of color in the water layer that forms the basis for distinguishing between milk fat (butter) and

vegetable fat (oleomargarine) or animal fats (lard, shortening, etc.)

Reagents:

Skellysolve B

0.2 Molar Hydroxylamine Hydrochloride in 95% ethyl alcohol

0.3 Molar Sodium Hydroxide in 95% ethyl alcohol

9% Hydrochloric acid

5% ferric chloride in 0.1 normal hydrochloric acid

Procedure for testing butter versus oleomargarine. Place to a small test tube (approximately 13 x 100 mm.) a small quantity (about the size of a small bead) of the fat and dissolve in 0.5 ml. of Skellysolve B or any petroleum solvent with boiling point approximately 60-65 degrees centigrade. Add 0.25 ml. of the hydroxylamine solution, 0.5 ml. of the sodium hydroxide solution and shake to mix the contents of the tubes. Heat for 20 minutes at approximately 70-75 degrees centigrade in a water bath or any container of hot water. Remove the tubes and add 0.5 ml. of 9% hydrochloric acid and 0.5 ml. of the ferric chloride solution. Dilute with 3 to 5 ml. of water and shake the tubes. The water layer in the tube containing butter will show a distinct pink to purple color whereas the tube containing the oleomargarine will show only a yellow color in the water layer.

Procedure for estimating mixtures of butter with other fats. When testing butter to determine whether the fat is pure butter or a mixture with other fats, proceed as follows:

Place the *same amount* of butter and unknown fat into separate small test tubes by carefully measuring the melted fats with standardized droppers or other devices which will deliver exact amounts. Sample sizes approximately 0.1 ml. in volume are preferable so that the color intensity will not be too great to estimate. Proceed with the reaction as described above and dilute the final reaction mixture with 2 to 3 ml. of water, using exact amounts in each tube. Compare the color intensity of the water layer of the unknown fat with the water layer of the tube containing butter. Sharp differences in color intensity will be noted if the unknown fat is a mixture of butter with vegetable fats or other animal fats. The following table illustrates values obtained with crude coconut oil, butter, oleomargarine, and mixtures of butter and oleomargarine:

Sample no.	Description	Color index [1]
1	75% butter — 25% oleomargarine	3.0
2	50% butter — 50% oleomargarine	2.0
3	25% butter — 75% oleomargarine	1.5
4	5% butter — 95% oleomargarine	0.5
B	Butter only	4.0
O	Oleomargarine only	0
C	Crude coconut oil	1.5

[1] Visually estimated color value based on butter as equal to 4.

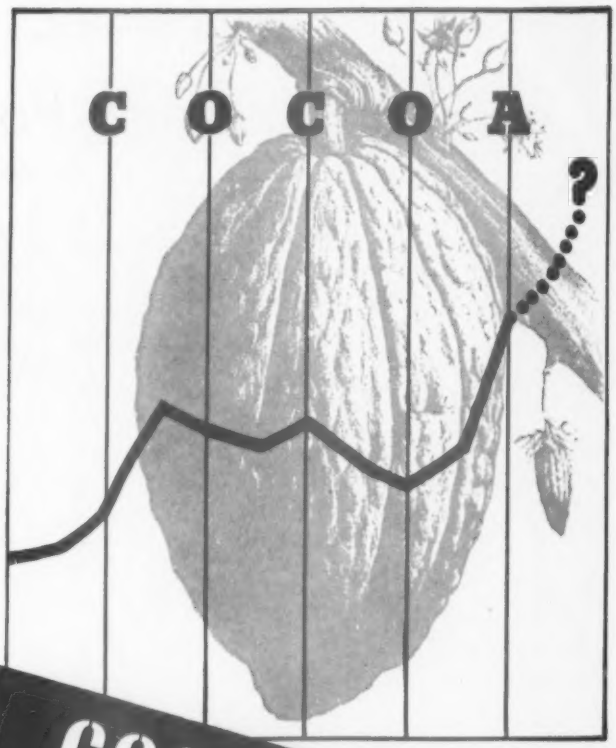
REFERENCES CITED

1. Buckles, E. R., and Thelen, C. J. Qualitative determination of carboxylic esters. *Anal. Chem.*, **22**, 676 (1950).
2. Feigl, Fritz. *Laboratory Manual of Spot Tests.* 1943, Academic Press, New York, N. Y., pp. 186, 187.
3. Hestrin, S. The reaction of acetylcholine and other carboxylic acid derivatives with hydroxylamine and its analytical applications. *J. Biol. Chem.*, **180**, 249 (1949).
4. Hill, U. T. Colorimetric determination of fatty acids and esters. *Anal. Chem.*, **19**, 932 (1947).
5. Lipmann, F., and Tuttle, L. C. A specific micro-method for the determination of acyl phosphates. *J. Biol. Chem.*, **159**, 21 (1945).
6. Thompson, Adrienne R. A colorimetric method for the determinations of esters. *Australian J. Sci. Res.*, 3A, 128-35, 1950.

Walter L. Nelson

Department of Biochemistry and Nutrition

Cornell University, Ithaca, New York



OUR ANSWER TO THIS...

IS THIS...

COCOA AND CHOCOLATE INTENSIFIERS

FOLLOW THE RISING CURVE of cocoa bean prices and you become acutely aware of a situation that means vanishing profits for the makers of coatings, confections, fondants and many other chocolate type goods. Happily for them, however, new technical advances employed by our Flavor Research Laboratories in the production of our COCOA and CHOCOLATE INTENSIFIERS has resulted in a group of specialties capable of effecting savings of as much as 25% and more of the natural chocolate used. It will be well worth your while to sample these new chocolate fortifiers... *NOW!*

Write for samples and prices ... on your letterhead, please. Specify type of product made and the pounds of chocolate ordinarily used for a properly flavored 100 lb. batch.

FRITZSCHE *Established* 1871 *Brothers, Inc.*

PORT AUTHORITY BUILDING, 76 NINTH AVENUE, NEW YORK 11, N. Y.

BRANCH OFFICES *and* °STOCKS: *Atlanta, Georgia, Boston, Massachusetts, °Chicago, Illinois, Cincinnati, Ohio, Cleveland, Ohio, °Los Angeles, California, Philadelphia, Pennsylvania, San Francisco, California, St. Louis, Missouri, °Toronto, Canada and °Mexico, D. F.* FACTORY: *Clifton, N. J.*

DIRECTORY

The Institute of Food Technologists

President

PHILIP K. BATES
Carnation Research Labs.
8015 Van Nuys Boulevard
Van Nuys, California

President-Elect

LAVERNE E. CLIFCORN
Continental Can Co. Inc.
4645 W. Grand Avenue
Chicago 39, Illinois

Executive Secretary

CHARLES S. LAWRENCE
176 W. Adams Street
Chicago 3, Illinois

Assistant Executive Secretary

MARIAN A. GILCHRIST
176 W. Adams Street
Chicago 3, Illinois

Treasurer

AKSEL G. OLSEN
General Foods Corporation
1125 Hudson Street
Hoboken, New Jersey

Assistant Treasurer

ARTHUR N. PRATER
Gentry Division
Consolidated Grocers Corp.
837 N. Spring Street
Los Angeles 12, California

Executive Committee of the Council

B. S. Clark, B. E. Proctor, P. K. Bates, A. G. Olsen, C. O. Ball, G. E. Brissey, H. C. Diehl, G. F. Garnatz, A. C. Richardson

Councilors-at-Large

Terms Expire 1955: C. O. Ball, E. J. Cameron, K. G. Dykstra, F. W. Fabian, M. A. Joslyn.

Terms Expire 1956: B. S. Clark, J. A. Dunn, C. N. Frey, L. A. Hall, H. S. Olcott.

REGIONAL SECTION CHAIRMEN, SECRETARIES AND COUNCILORS

CHICAGO, No. 1: Chairman, S. F. Brockington. Secretary, John L. Heid, Putman Publishing Co., 111 E. Delaware Pl., Chicago 11, Ill. Councilors, S. F. Brockington, J. M. Jackson, R. F. Cohee, D. A. Huber, M. Ives, R. G. Tischer.

NORTHERN CALIFORNIA No. 2: Chairman, H. S. Olcott. Secretary, Elise Hoffman, 425 Battery St., San Francisco, Calif. Councilors, H. T. Griswold, E. E. Jacobs, A. C. Richardson.

NORTHEAST, No. 3: Chairman, J. Donovan. Secretary, Lyle M. Richardson, 332 Franklin St., Wrentham, Mass. Councilors, M. E. Highlands, L. B. Sjostrom.

SOUTHERN CALIFORNIA, No. 4: Chairman, M. S. Dunn. Secretary, Gordon L. Merchant, Merck & Company, Inc., 1855 Industrial St., Los Angeles 21, Calif. Councilors, R. H. Higby, M. E. Powell, W. E. Baier.

ST. LOUIS, No. 5: Chairman, C. M. Harrold, Jr. Secretary, James C. Fruin, A. C. L. Haase Co., 4300 N. Geraldine, St. Louis 15, Mo. Councilor, B. A. Hall.

NEW YORK, No. 6: Chairman, F. C. Baselt. Secretary, Eleanor M. Crozier, United Fruit Co., Pier No. 3 North River, New York 6, N. Y. Corres. Secretary, W. A. Maclinn, N. J. Agri. Exp. Sta., New Brunswick, N. J. Councilors: C. N. Frey, R. F. Light, O. Skovholt, S. L. Galvin, A. A. Schaal.

FLORIDA, No. 7: Chairman, R. W. Kilburn. Secretary, Donald J. O'Brien, American Can Co., Res. Div., P. O. Box 1732, Tampa, Fla. Councilor, W. R. Roy.

WESTERN NEW YORK, No. 8: Chairman, E. L. Sexton. Secretary, Catherine Personius, N. Y. S. College of Home Econ., Cornell Univ., Ithaca, N. Y. Councilor, W. S. Conway, Jr.

GREAT LAKES, No. 9: Chairman, Pauline Paul. Secretary, H. Clifford Scott, Owens-Illinois Glass Co., Packaging Research Div., Toledo, Ohio. Councilor, L. J. Minor.

PHILADELPHIA, No. 10: Chairman, C. D. Pratt. Secretary, Edwin C. Dryden, Eastern Regional Research Lab., Philadelphia 18, Pa. Councilor, J. P. Crimmins.

MARYLAND, No. 11: Chairman, L. V. Strasburger. Secretary, William J. Hart, Jr., John H. Dulany & Son, Inc., Fruitland, Md. Councilors, A. H. Warth, E. G. Heyl.

PUGET SOUND, No. 12: Chairman, G. Ivor Jones. Secretary, Kathryn L. Osterhaug, U. S. Fish & Wildlife Service, 2725 Montlake Blvd., Seattle 2, Wash. Councilor, C. W. Hurlbut.

AMES, No. 13: Chairman, Glen E. Cooper. Secretary, Frances Carlin, Foods & Nutrition Dept., Iowa State College, Ames, Iowa. Councilor, W. H. Montgomery.

MOHAWK VALLEY, No. 14: Chairman, M. Glickstein. Secretary, Carl W. Nordgren, Chr. Hansen's Laboratory, Inc., Little Falls, N. Y. Councilor, M. E. DeBenedictis.

OHIO VALLEY, No. 15: Chairman, G. F. Garnatz. Secretary, Mary E. Green, Schl. of Home Econ., Ohio State Univ., Columbus 10, Ohio. Councilor, N. H. Volle.

OREGON, No. 16: Chairman, H. Y. Yang. Secretary, Curtis J. Wilder, Food Technology Dept., Oregon State College, Corvallis, Ore. Councilor, P. R. Elliker.

DIXIE, No. 17: Chairman, C. D. Schiffman. Secretary, Carroll F. Neff, 193 Princeton Way, N. E., Atlanta 6, Georgia. Councilor, J. O. Mundt.

TEXAS, No. 18: Chairman, B. L. Golub. Secretary, Kenneth K. Keneaster, Converted Rice, Inc., P. O. Box 1752, Houston 1, Texas. Councilor, A. V. Moore.

AUSTRALIA NORTHERN, No. 19: Chairman, J. F. Kefford. Secretary, V. M. Lewis, 25 Byron St., Coogee, N. S. W., Australia. Councilor, J. R. Vickery.

INDIANA, No. 20: Chairman, V. R. Rupp. Secretary, Verna McCallum, 941 N. Meridian, Indianapolis 6, Ind. Councilor, N. W. Desrosier.

PITTSBURGH, No. 21: Chairman, G. W Seagren Secretary, Paul Somerville, H. J. Heinz Company, 1060 Progress St., Pittsburgh 30, Pa. Councilor, D. M. Gray.

BRITISH COLUMBIA, No. 22: Chairman, P. A. Sunderland. Secretary, Wm. D. Sargent, 1512 Boundary Rd., Vancouver, B. C., Canada. Councilor, C. C. Strachan.

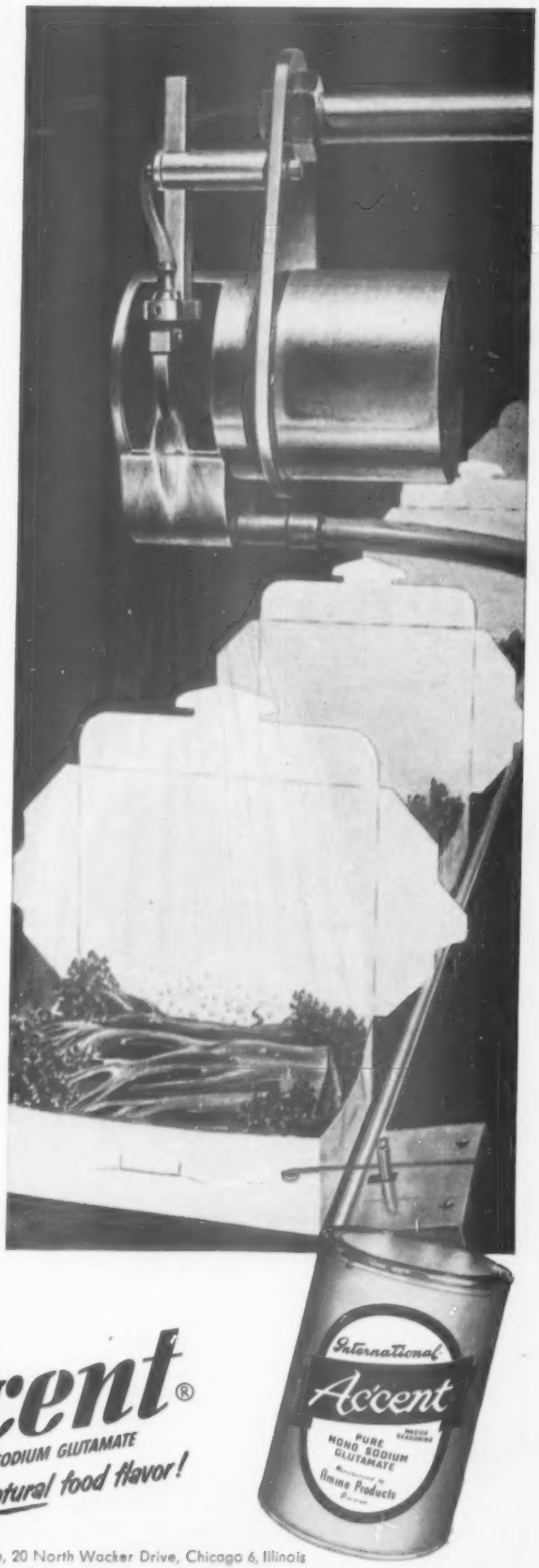
AUSTRALIA SOUTHERN, No. 23: Chairman, F. C. Elsworth. Secretary, Marjorie K. Paxton, H. J. Heinz Co. Pty. Ltd., Bendigo St., Richard, Vic., Australia. Councilor, G. F. Midwood.

MEMBERSHIP

Write to nearest regional secretary, if within an area covered by a regional section, or to the Executive Secretary of the Institute for an application form and information regarding qualifications and classifications.

Here it is!

The new method of adding Ac'cent to frozen vegetables



New Ac'cent Machine gives flavor-edge to frozen foods

Now, after three years in the development stage, a new Ac'cent dispenser makes it possible for frozen vegetable processors to enjoy the flavor enhancement advantages of Ac'cent!

Accurate measurements of monosodium glutamate in a liquid solution are applied by the new machine to vegetables before freezing. It is an automatic, high-speed operation—efficient and economical.

The machine was designed and developed by Ac'cent technical experts in co-operation with a food engineering company. It is able to treat as many as 400 cartons a minute. There is no drip-loss, and it assures *uniform flavor control*. It also is versatile, for it can be used by canners and by processors of other frozen foods.

Use of the new machine brings *two immediate marketing advantages* to the frozen vegetable processor:

1. *Ac'cent*, pure monosodium glutamate, gives the product a distinct flavor advantage—a longer-lasting natural, fresh flavor.
2. *Ac'cent* gives the product a longer shelf-life because of the improved flavor retention.

The successful solution of this processing problem is another example of the help given to many of our customers by the exclusive Ac'cent technical service on new products, timing devices, applicators and a variety of processing problems. New developments from our laboratories have given many of them a lasting competitive advantage.

That's another reason why you should always specify Ac'cent when buying monosodium glutamate. You get so much more when you do!

Ac'cent®
PURE MONOSODIUM GLUTAMATE
...builds natural food flavor!

Full information about the new Ac'cent liquid dispensing machine will be sent upon request.

AMINO PRODUCTS Division of International Minerals & Chemical Corporation, 20 North Wacker Drive, Chicago 6, Illinois

Diamond Crystal Alberger Salt is

America's largest-selling High-Grade* salt

because...

the exclusive Diamond Crystal Alberger System produces:

Purity—99.95% Sodium Chloride.

Uniformity—maximum purity variation ±0.01% . . . screened to a standard for each food product.

Cleanliness—lowest insolubles of any commercial grade of salt.

Low heavy metals—averages less than 1.5 part per million of pro-oxidants copper or iron.

**The premium grade salt used by food processors.*

FOOD TECHNOLOGIST AT YOUR SERVICE

For free consultation on choice and application of the right salt for your food products—call, wire or write:

Technical Service Dept. B
Diamond Crystal Salt Co.
St. Clair, Michigan
Phone—296

SELECTED ABSTRACTS

(Continued from page 24 preceding technical papers)

sorbic acid indicate that there is no objectionable taste, odor or color imparted in the cheese by amts. of sorbic acid which are fungistatic.

Antibiotics in food processing. Experimental preservation of fish and beef with antibiotics.

TARR, H. L. A., BOYD, J. W., AND BISSETT, H. M. *J. Agr. Food Chem., 2,* 373-5 (1954).

Spoilage of whole eviscerated fish was retarded markedly by ices contg. 1-4 p.p.m. of chlorotetracycline, by holding 6 days at —1° C. in sea water contg. 2 p.p.m., or by 1-min. immersions in solns. contg. 50 or 100 p.p.m. of the antibiotic prior to icing. The effect of different conditions on stability of chlorotetracycline in flesh foods was studied. Owing to presence of interfering substances, it was not possible to detect, by the usual microbiol. assay procedure, chlorotetracycline in flesh of fish so iced.

TASTE TESTING

Sensory tests and consumer acceptance.

HARRIES, J. M. *J. Sci. Food Agr., 4,* 477-82 (1953).

Some implications of the distinction between the consumer-acceptance test and the analytical taste-panel test are discussed. The analytical type panel may evaluate a sample for a no. of different characteristics. Combination of these results to det. "overall quality" is not recommended. "Quality" should be evaluated by consumer tests. The direct-difference test is considered briefly and an attempt to use such tests to measure intensity is shown.

ORGANIC CHEMISTRY

Multiple-branching in amylopectin.

HIRST, E. L., AND MANNERS, D. J. *Chemistry & Industry,* 224-5 (1954).

The mol. structure approximates rather more closely to a "laminated," and therefore elongated mol. This suggestion is in accord with the observed approx. linear relationship between the viscosity and mol. wt. of methylated and native amylopectins. Amylopectin appears to differ from glycogen in the degree of multiple-branching.

Polysaccharide aryl carbamates. IV. Partly substituted and cross-linked starch carbamates.

WOLFF, I. A., WATSON, P. R., AND RIST, C. E. *J. Am. Chem. Soc., 76,* 757-9 (1954).

The prepn. of partially substituted starch carbamates both in anhydrous pyridine and in aq. medium is described. Gelatinization-resistant starches result when as little as one hexamethylenedicarbamyl cross-link for each 500 anhydroglucose units is introduced. Many of the starch carbamates still show the cross under polarized light and are microscopically indistinguishable from untreated corn starch.

PATENTS

Agents for preventing loss of gloss in candy coatings.

CROSS, S. T. Assignor to Atlas Powder Company. *2,671,027,* March 8, 1954.

A sugar fat bon-bon coating in which the wt. ratio of fat to sugar lies between the inclusive limits of 80/20 and 25/75 inhibited against dulling by the incorporation of a mixt. comprising a partial ester of a higher fatty acid and a polyoxyethylene deriv. of a partial ester of a higher fatty acid.

Low-methoxyl pectin gels and method of making the same.

SHEPHERD, D., MCCREADY, M., AND OWENS, H. S. Assignors to the U. S. A. *2,673,157,* March 23, 1954.

A one-package compn. of matter suitable for prepg. an edible gel by incorporation in an edible aq. liquid without application of heat, comprising a dry mixt. of a solid soln. of a low-methoxyl pectin in sugar and a source of Ca, the solid soln. contg. at least about 10 parts sugar per part of low-methoxyl pectin.

MAPLEAROME

Imitation Maple Flavor Base

"The Essence of Good Taste"

...Produced mainly from materials of vegetable origin, this perfect Imitation Maple Flavor Base is a dependable reproduction of the aroma of Maple Sap . . .

Florasynth LABORATORIES, INC.
CHICAGO 6 • NEW YORK 62 • LOS ANGELES 21

Detroit 2 • Cincinnati 2 • Dallas
Memphis • New Orleans 12 • St. Louis 2
San Francisco 7 • San Bernardino
Florasynth Labs. (Canada) Ltd.
Montreal • Toronto • Vancouver • Winnipeg
Productos y Laboratorios Florasynth, S.A.

PURE VANILLA CONCENTRATE
VERITAS

Florasynth LABORATORIES, INC.
CHICAGO 6 • NEW YORK 62 • LOS ANGELES 21

CINCINNATI 2 — DETROIT — DALLAS — MEMPHIS — NEW ORLEANS 12
ST. LOUIS 2 — SAN FRANCISCO — SAN BERNARDINO
FLORASYNTH LABS. (Canada Ltd.) — MONTREAL — TORONTO — VANCOUVER — WINNIPEG
PRODUCTOS Y LABORATORIOS FLORASYNTH, S.A. — MEXICO 11, D.F.

A Guide to a Better Beginning!

imitation
CASSIA OIL
by **FLORASYNTH**

Garlic Oil • Cardamom Oil • Black Pepper Oil
and many other spice oils

Florasynth LABORATORIES, INC.
CHICAGO 6 • NEW YORK 62 • LOS ANGELES 21

RESINOL COFFEE

SYNTHAROME IMITATION COFFEE FLAVOR

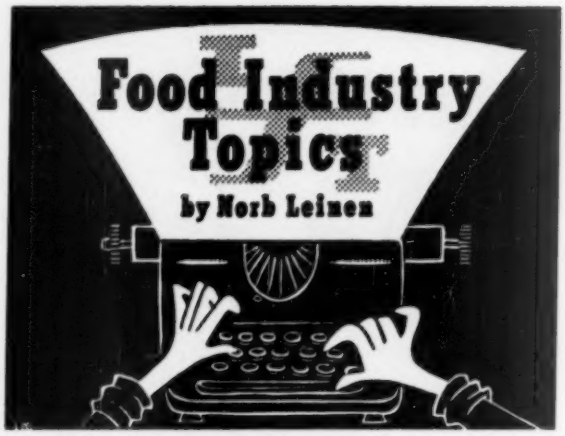
PURE COFFEE CONCENTRATES
(Fluid Veritas)

Florasynth LABORATORIES, INC.
CHICAGO 6 • NEW YORK 62 • LOS ANGELES 21

CINCINNATI 2 — DETROIT — DALLAS — MEMPHIS — NEW ORLEANS 12
ST. LOUIS 2 — SAN FRANCISCO — SAN BERNARDINO
FLORASYNTH LABS. (Canada Ltd.) — MONTREAL — TORONTO — VANCOUVER — WINNIPEG
PRODUCTOS Y LABORATORIOS FLORASYNTH, S.A. — MEXICO 11, D.F.

polak's frutal works
middletown, new york
Branch Office: Chicago, Illinois
800 North Clark Street

essential oils
terpeneless oils
flavoring materials
aromatic chemicals
concentrated oils
perfume bases



. . . *in the public interest*

An interesting resolution covering "the indiscriminate sale of artificially sweetened foods" was issued by the Association of Food and Drug Officials of the United States at the organization's regional convention at Des Moines, Iowa, in May. Resolution IX cites the following as necessary precautionary measures: (1) that synthetic sweeteners such as saccharin or sucaryl be utilized in special dietary foods only, with distinctive and informative labeling to be employed; (2) that such foods be segregated from ordinary foods in retail outlets; (3) that shelf display and advertising material stress the special character of the articles; (4) that the label shall bear the identification and percentage by weight of the artificial sweetener in the product; (5) that the words, "Special Dietary" and/or "For Dietary Purposes Only," appear on the principal label in type of equal style and prominence with name of product; (6) that manufacturers and producers of foods for special dietary use shall, in addition to the above, declare the true carbohydrate, fat, protein, and caloric content on the labeling of the product as an additional informative designation.

◆ ◆ ◆

The research function of The Refrigeration Research Foundation was stressed by Dr. Samuel Cates Prescott, chairman of the Board of Governors of TRRF, at the organization's annual meeting in Boca Raton, Fla., on April 26. Said Dr. Prescott: "While we are especially concerned with problems and developments of immediate professional and economic interest, we should be forward-looking enough at all times to envision some of the relations that newly acquired information in pure science, or studies in physics, chemistry, or biology already in progress are likely to have on the future of the refrigeration industry. Recently, I read of an inquiry as to whether the preservation of foods by sterilization through the application of atomic energy, now much in a preliminary state of investigation, will render refrigeration unnecessary or greatly reduce the volume of its operations. The question seemed to me superficial and not inspired by really intelligent thinking. As I foresee the future, my belief is that it will not do so in any degree, at least not for a very long time, but, on the contrary, may work in the reverse direction. I think it will still be necessary to slow down by reduced temperatures the inter-molecular, or oxidative, or enzymic changes that might conceivably be set up, or which naturally proceed at ordinary or elevated temperatures. Such changes, as we now have reason to believe, take place in some canned foods and in dehydrated products. Thus, a new aspect of refrigeration reaction might be brought into existence which will require new research for explanation. The important thing is for us to become alert and aware of the manner in which new knowledge may affect the procedures we already employ, and to be ready to undertake the next steps which our new knowledge makes implicit. As a research foundation, we should continue to foster some pure science studies, along with those of more obvious immediate application to the recognized procedures of everyday warehouse operations. It is greatly to the

(Continued on page 32)

Choose from fmc's FAMOUS FAMILY OF M & S FILLERS

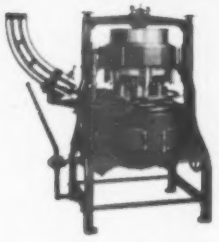
The Standard for Progressive Canners because they are UNSURPASSED for ACCURACY

FMC M&S Plunger Fillers have set new standards for high accuracy filling. On the basis of thousands of accuracy of fill tests, by weight testing methods, M&S Fillers are *unsurpassed for accuracy!*

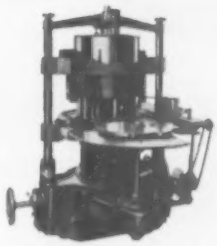
And M&S Fillers lead the field for *versatility*, too: no other fillers can handle as wide a range of liquid, semi-liquid and heavy semi-solid products.

These fillers are engineered for heavy duty and long life. Operating parts are fully enclosed. Drive gears run in oil. All inspection, lubrication, and adjustment points are readily accessible. Non-corrosive metals are used on all contact surfaces. Special "No-Can, No-Fill" feature prevents product waste.

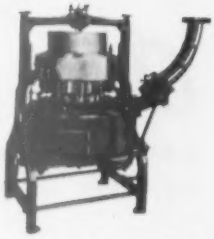
By all comparisons, these are the finest fillers made — designed and built to perform better at lower cost.



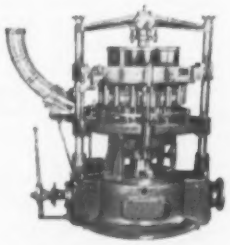
FMC M & S 6 Pocket Fillers
Handles virtually any liquid, semi-liquid or semi-solid product. Can be furnished for can sizes from 202 x 102 to 610 x 910. Speed: 150 CPM in small containers.



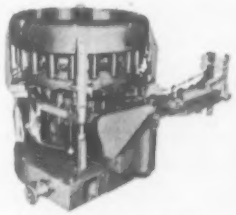
FMC M & S 9 Pocket Fillers
For filling pulps, pastes and liquids in containers from 202 x 203 to 404 x 611 size. Speed: up to 150 CPM on light liquids; 250 CPM on heavier products.



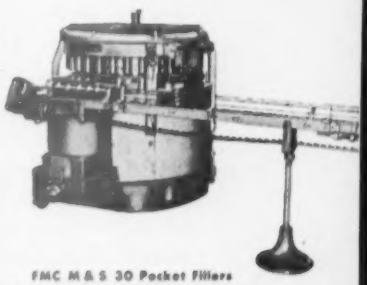
FMC M & S 10 Pocket Fillers
Handles a host of products of varying consistencies from condensed milk to heavy dog food for containers ranging in size from 202 x 102 to 404 x 604. Speeds up to 300 CPM.



FMC M & S 15 Pocket Fillers
For container sizes up to 211 x 400. Handles citrus concentrates, baby foods and other semi-liquid free flowing products at up to 450 CPM.



FMC M & S 20 Pocket Fillers
Delivers up to 500 CPM using jars or cans. Typical products filled are lubricating oil, apple sauce, and chocolate syrup. Handles containers within a range of 202 to 401 diameter.



FMC M & S 30 Pocket Fillers
Designed for baby foods and similar products. Handles 5 to 8 ounce jars or cans at speeds of 600 CPM.

There's an M & S Filler for virtually every product, can size, and can line speed !!

Write for full information, or call your nearest FMC representative.

FOOD MACHINERY AND CHEMICAL CORPORATION
Canning Machinery Division

General Sales Offices:

WESTERN: SAN JOSE . CALIFORNIA **EASTERN:** HOOPESTON, ILLINOIS

REVOLUTIONARY NEW CLEANING METHOD FOR HIGH TEMPERATURE EQUIPMENT

Chelation AND WHAT IT MEANS TO YOU IN SAVINGS

KLENZADE

O-R SYSTEM OF CLEANING

SAVES YOU HUNDREDS OF DOLLARS ANNUALLY IN TIME, MATERIALS, WATER, STEAM

Again Klenzade leads with a remarkable new cleaning chemistry advance — *Chelation.* Initial cleaning with Klenzade O-R Organic Acid Cleaner is followed with Klenzade O-R Alkaline Cleaner. This produces an amazing series of chemical reactions — each one super-powered for a variety of specific cleaning actions never even approached before. The milkstone dissolving properties of the organic acid cleaner are complemented and enhanced by the soil dissolving properties of the alkaline cleaner, resulting in *double action* cleaning through chemical fortification. "Chelation" prevents precipitation of water-borne minerals and assures film free surfaces. Let us demonstrate to you that this revolutionary chemical cleaning advance — the Klenzade O-R System — will definitely save you hundreds of dollars annually.

Write for New Cleaning Instructions for HTST Pasteurizers and Evaporators

ORGANIC ACID CLEANER • *Single Cycle Cleaning* • ALKALINE CLEANER

KLENZADE PRODUCTS, INC.
BELOIT, WISCONSIN
Branch Offices and Warehouses in Principal Cities

FOOD INDUSTRY TOPICS

(Continued from page 30)

credit of our foundation that the list of such studies already sponsored by it is a long and growing one."

At the same meeting, the following were selected as leaders of The Refrigeration Research Foundation for the coming year: Dr. S. C. Prescott, chairman of the Board of Governors; Mr. Wm. A. Sizer, president; Mr. H. J. Nissen, vice president; Mr. Walter A. Kopke, treasurer; Mr. K. F. Stepleton, assistant secretary; Mr. H. C. Diehl, director and secretary.

. . . *things new under the sun*

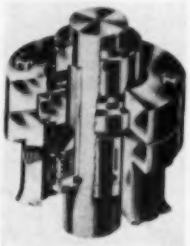
A new type of Roche vitamin B2, known as riboflavin-5'-phosphate sodium, is now available in quantity for pharmaceutical manufacturers from Hoffman-La Roche, Inc., Nutley, N. J. Possessing over 200 times the solubility in water of the form commonly used up to this time, it makes possible higher and more successful parenteral dosages. The new product has unique properties which make it valuable in the manufacture of vitamin parenteral solutions, elixirs, water-dispersible multivitamin drops and gelatin capsules, and in tablets in which rapidly soluble riboflavin is desirable. Thus, pharmaceutical manufacturers may now prepare higher dosage forms of this vitamin for the medical profession than hitherto possible. The stability of Roche riboflavin-5'-phosphate sodium in B-complex parenteral solutions, with and without vitamin C, has been demonstrated by storage tests. No losses were observed in straight riboflavin-5'-phosphate sodium solutions with concentrations as high as 30 mg. per ml.

◆ ◆ ◆

Eastman Chemical Products, Inc., Kingsport, Tenn., has announced completion of an evaluation program to determine the **effectiveness of butylated hydroxytoluene (BHT) as a food-grade antioxidant.** According to Mr. Henry L. Ford, vice president of the company, "results indicate that the area of greatest usefulness will probably involve a synergistic combination of BHT with the well-known antioxidant, butylated hydroxyanisole (BHA). We are making such a combination available to the food industry under the name, Tenox IV. It is composed of 20% BHA and 20% BHT dissolved in vegetable oil." The company believes the combination economically increases the shelf life of many products to a greater degree than does the use of BHA or BHT alone, but cautions that the efficiency of either antioxidant used singly, or the combination of the two, is selective, and that individual food products must be tested before an intelligent decision can be made.

◆ ◆ ◆

A newly designed, easy-to-install mechanical shaft seal is reported to have established a performance record during a recent large-scale test on the cargo pumps of oil tankers. The Type 9 Seal, manufactured by the Crane Packing Co., 407 S. Dearborn St., Chicago 13, Ill., can be used to handle practically all corrosive liquids at temperatures up to 500° F. Flexible sealing members are made of chemically inert Du Pont Teflon. Springs and metal parts can be furnished in the metallurgical specification best suited to the service. Sizes are available to specification. For more detailed information, write Dept. FRC at the above address.



◆ ◆ ◆

Nacconol 8L, a new liquid form of Nacconol synthetic detergent, is now being produced by National Aniline Division, Allied Chemical & Dye Corp., 40 Rector St., New York 6, N.Y. Nacconol 8L is exceptionally light in color, has a pleasant characteristic odor, a very low haze-point, no precipitation at temperatures down to freezing, and a low salt content. Users, formulators, and repackers of synthetic detergents may obtain a sample by writing to the above address.

(Continued on page 34)

Easier to Handle... Lighter... Smaller!

The New Polyethylene Shipping Container

FOR Roccal®

SANITIZING AGENT 50% CONCENTRATE

6 Major Advantages OF NEW Roccal CONTAINER

1. **NON-RETURNABLE**
2. **NO DEPOSIT**
3. **NON-BREAKABLE**
4. **EASY TO SHIP AND STACK**
5. **WIDE-MOUTH OPENING**
6. **REUSE OR SALVAGE**

Save handling time and labor. Order the 50% concentrate of Roccal, the original quaternary ammonium germicide, in new 5 gallon polyethylene container. A simple "one-man" job to handle this new unit . . . measures but 11″ x 11″ x 11″, weighs only 45 lbs. completely packed . . . yet practically indestructible.

Roccal is laboratory controlled and tested. In recommended dilutions is non-poisonous, non-irritating to skin, virtually odorless, tasteless. Roccal does a better sanitizing job.

USE ROCCAL TO SANITIZE:

- STORAGE BINS
- FREEZING UNITS
- REFRIGERATORS
- CONVEYORS
- TANKS
- PROCESSING EQUIPMENT
- PACKAGING EQUIPMENT
- AIR CONDITIONING AND COOLING SYSTEMS
- WALLS AND FLOORS
- WASH ROOMS
- TRUCKS
- AND AS A HAND RINSE FOR PERSONNEL

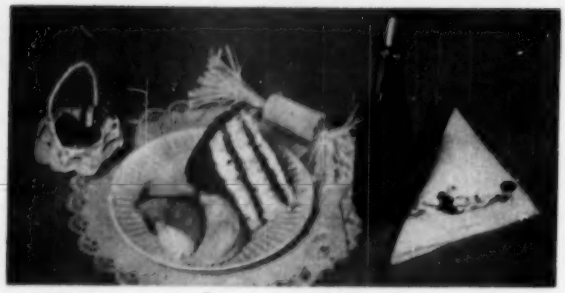
For further details on Genuine Roccal Brand Sanitizing Agents Contact your local supply dealer or write—

Sterwin Chemicals INC.

Subsidiary of Sterling Drug Inc.

1450 Broadway, New York 18, N. Y.

for flavors



that make

them ask

for more!

GIVAUDAN FLAVORS have provided keys to sales success for many manufacturers—of confections, ice creams, soft drinks, baked goods, puddings, cordials and other products.

Our chemists and flavor experts have developed a complete, quality line of basic flavor materials, natural fruit flavors and imitation flavors to meet every need. They will gladly help you select the right flavors for your products...or work closely with you to develop distinctive individual flavors to meet your special requirements.

Givaudan Flavors Inc.

330 West 42nd Street, New York 36, N. Y.

Branches: Philadelphia • Boston • Cincinnati • Detroit
Chicago • Seattle • Los Angeles • Toronto

FOOD INDUSTRY TOPICS

(Continued from page 32)

The Golden Dipt Division of Meletio Sea Food Co., St. Louis, Mo., is distributing samples of its ready mixed breading in a new package of CENCORAP material at trade shows. The package, developed by Central States Paper and Bag Co., 7510 Delmar Blvd., St. Louis 5, Mo., is made from a polyethylene coated kraft paper which is heat-sealed into a moisture-proof pouch. The two-color exterior contains directions for use of the breading on various products. The inside polyethylene plastic lamination protects the powdered egg and milk solids against humidity and keeps the breading sample fresh for a considerable period.

◆ ◆ ◆

Westicide, a new highly concentrated emulsifiable insecticide for the control of insects commonly found in food processing and food handling establishments has been developed by West Disinfecting Co., 42-16 West St., Long Island City, N. Y. A water-soluble insecticide, Westicide is formulated primarily for contact and residual spraying operations in such locations as meat packing plants, canneries, bottling plants, and breweries. It is a concentrated formulation consisting of pyrethrins, piperonyl butoxide with an emulsifier, and petroleum hydrocarbons—the least toxic materials for effective insect control. The spray is relatively odorless, and can be used around food, food products, or food handling equipment, although it is recommended that these products be kept from direct contact with the insecticide.

◆ ◆ ◆

Although the metal can appears destined to broaden a number of consumer markets, the **canning of soft drinks** offers the most exciting and possibly the greatest long-range potential for the metal container since the introduction of the beer can two decades ago, according to American Can Co. Giving impetus to this young but rapidly growing industry is the firm's new flat-top soft drink can which it is now producing after prolonged research and development work. Mr. Wm. C. Stolk, Canco president, whose company developed the first beer can, said: "It is still too early to make any firm predictions, but if the consumer acceptance trends that have marked the success of the beer can are paralleled in the soft drink business, then the volume of cans sold may eventually be twice that of the present beer can volume. This would mean 12 to 13 billion soft drink cans per year."

◆ ◆ ◆

A new, airless abrasive blasting machine for the reconditioning cleaning of 30 and 55 gallon steel drums before painting and coating operations is announced by American Wheelabrator & Equipment Corp., Mishawaka, Ind. It handles the type of drums used for holding chemicals, industrial process materials, foods, oil, gasoline, grease, asphalt, paint, varnish, foundry core binders, plastics, and the like. The machine is capable of cleaning the exterior surfaces of closed-end drums and both the exterior and interior surfaces of open-end drums, together with the lids.

◆ ◆ ◆

Alsteele Granulators in a range of 4 sizes, having such exclusive features as all steel construction, absolutely no flyback of materials, dust type construction, field stripping ease of disassembly, are now being introduced by Alsteele Engineering Works, Inc., 82 Herbert St., Framingham, Mass. Models include 1½ hp. with 4½" x 6" throat opening, 5 hp. with 5" x 10" throat opening, 25 hp. with 7" x 18" throat opening, and 40 hp. with 9" x 24" throat opening. Dicing and chopping equipment is available as specially engineered attachments to the standard machines, eliminating the need for excess capacity where such operations are carried out on a part-time basis.

◆ ◆ ◆

The Borden Company has introduced a **rolled aluminum container** for its five varieties of 6-ounce process cheese spreads, using a vapor-vacuum pry-off closure designed by the White Cap Company, 1819 N. Major Ave., Chicago, Ill. The new container is currently on a trial basis on the west coast as

(Continued on page 36)

TRY THIS

flexible glass

For Safer FLUID FOOD TRANSMISSION

Tygon flexible plastic tubing well deserves to be called "the flexible glass." It is crystal clear for easy solution visibility. Flexible as a piece of string, it simplifies set-up and dismantling of lines. Tough, abrasion-resistant, and unbreakable, it can take the roughest kind of service. It doesn't chemically deteriorate with age; it cleans easily and thoroughly, can be steam sterilized if desired. It is endorsed and approved by medical authorities and manufacturers of food processing equipment for safe, pure handling of food products.

Yes, Tygon flexible plastic tubing is the clear solution to many fluid handling problems. It's available in bore sizes from 1/16th inch to 2 inches. And for high pressure use (250-300 psi) is available with an outer braid reinforcement of stainless steel.

PRODUCT OF

U.S STONEWARE

Akron 9, Ohio

Plastics and Synthetics Division

Write for Bulletin T-87 just off the press — 24 pages of technical data describing how and where you can use Tygon Tubing. U. S. Stoneware Co., Akron 9, Ohio, Plastics and Synthetics Division.

IS YOUR FOOD PRODUCT LISTED HERE?

	Dehydrated Soups	Ice Cream Stabilizers
	Dessert Mixes	Marshmallow Toppings
	Flavoring Emulsions	Meringues
Aspics	French Dressing	Milk Puddings
Beer	Frozen Fish	Pie Fillings (Dry)
Beverages	Frozen Fresh Fruit	Pumpkin Pie Filling
Cake Icings	Frozen Fruit Juices	Ripple Ice Cream Syrup
Canned Fruit	Fruit Fillings (Pie)	Sauces (Prepared)
Cheese Spreads	Fruit Juices	Sherbet Stabilizers
Chocolate Milk	Fruit Pie Fillings	Soups
Chocolate Syrups	(canned, ready-to-serve)	Syrups
Confectionery	Gas Whipped Cream	Water Gel Desserts

..AND YOUR IMPROVEMENT PROBLEM HERE?

- ☐ Binding
- ☐ Bodying
- ☐ Emulsifying
- ☐ Gelling
- ☐ Modifying
- ☐ Stabilizing
- ☐ Suspending
- ☐ Thickening
- ☐ Custardizing milk & products containing milk solids
- ☐ Improving mouth-feel and flavor
- ☐ Increasing efficiency of component ingredients
- ☐ Modifying ice crystal growth
- ☐ Physical & anti-oxidant protectioo
- ☐ Thermally-reversible gels

THEN YOU'LL FIND YOUR ANSWER HERE!

*SeaKem is the trademark for the standardized, water-soluble, sea plant extractives manufactured by the Seaplant Chemical Corporation. Refined by rigidly controlled processes which insure dependable uniformity and purity, SeaKem "Colloids Out of the Sea" are light amber to colorless, free-flowing flaky powders. Available in a variety of types suitable for use in an unusually wide range of food applications (see lists above), SeaKem Products have won acceptance on the basis of proven advantages with leading manufacturers and processors.

Are your food product and improvement problem listed above? Then follow the lead of top food manufacturers and try SeaKem "Colloids Out of the Sea".* Discover how SeaKem Products can help improve *your* food product . . . make it better . . . easier to sell.

Whether your problem is an old story or "different from anyone else's", chances are SeaKem "Colloids Out of the Sea" and Seaplant Chemical's confidential laboratory service, can mean time and money to you. Fill out and mail coupon today for prompt attention.

CLIP AND MAIL FOR LATEST SEAKEM TECHNICAL BULLETINS

NAME ..... TITLE .....

COMPANY .....

STREET .....

CITY ..... ZONE ..... STATE .....

Type product and problem .....

Check here if you desire samples as well as technical bulletins ☐

Serving Industry with "Colloids Out of the Sea"

SEAPLANT CHEMICAL CORPORATION

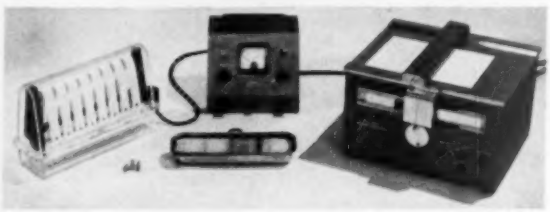
42 David St., New Bedford, Massachusetts

FOOD INDUSTRY TOPICS

(Continued from page 34)

an additional means of merchandising Borden's cheese products. The aluminum container comes in 12 glossy colors—silver, ruby, turquoise, emerald, topaz, aquamarine, gold, amethyst, yellow sapphire, mandarin red, blue sapphire, and bronze.

◆ ◆ ◆

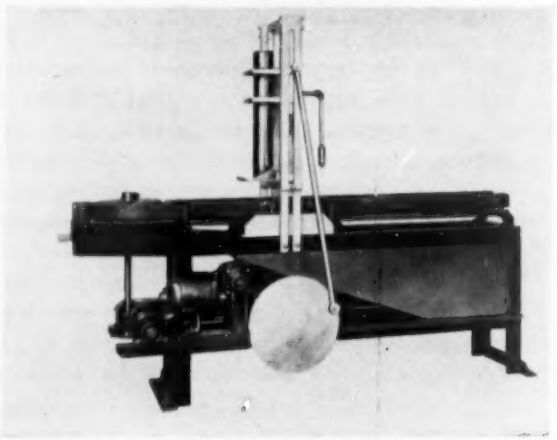


Directed toward the objective of putting the separation of components and the measuring of concentration by electrophoretic techniques on a simple, reproducible basis, the new Spinco Model R Paper Electrophoresis System, manufactured by Specialized Instruments Corp., 704 O'Neill Ave., Belmont, Calif., is organized around an automatic electronic curve-drawing integrator, two 8-strip electrophoresis cells, and a constant-current/constant-voltage regulated power supply. Procedures and corresponding equipment have been integrated to routinize each step from the application of accurately-metered samples to the automatic chart-recording of final results.

◆ ◆ ◆

A new **super-strength insect spray** that is guaranteed safe for use around food, and which will greatly aid in keeping kitchens roach-free has been perfected by Campbell Chemicals Inc., 3807 S. Kings Highway, St. Louis, Mo. Named "Camicide," the new spray has three to eight times more insect-kill than ordinary insecticides, yet can be freely used around food in storage areas or on open preparation areas. Camicide is non-poisonous, non-toxic, non-irritating, tasteless, and stainless. It can be sprayed near cooking utensils, dishes, pots and pans in cupboards and in closets without bad effects. It has been registered with the USDA, and is covered by Products Liability Insurance. Camicide is sold in an 8-ounce household size and a large economy size of 16 ounces. It is also available in a 12-ounce aerosol dispenser.

◆ ◆ ◆



The Burgee Automatic Can Opener, a new unit that does the work of four men, has been introduced by the F. H. Langsenkamp Co., 237 E. South St., Indianapolis, Ind. The fully automatic Burgee Opener empties and rinses up to 20 No. 10 cans per minute, and handles any liquid or semi-liquid that will drain from a 4" opening. The machine prevents loss due to spilling or splashing of contents. It can be used with its com-

panion unit, the Burgee Can Crusher, to form a continuous production line. Size—10'1½" long, 34" wide. Net weight—806 pounds. Motor—¾ hp., 220/440-60-3, 1725 rpm., reduced to 48 rpm. for 20 cans per minute. Pump optional.

◆ ◆ ◆

A handy pocket-size chart of Fahrenheit and Centigrade temperature equivalents can be had without obligation from the Moeller Instrument Co., Richmond Hill 18, N.Y., or from their representatives located in principal cities. The reverse side of the chart illustrates by means of an animated demonstration the easy reading qualities of Moeller thermometers. The chart is 8½" x 3½" in size.

◆ ◆ ◆

The full normal capacity range of plastic welding operations for packaging and specialty manufacturing is covered by newly designed high-frequency Ectrotherm generator line. The basic unit has all operating sub-assemblies mounted on sliding drawer type chassis units for immediate change-over of power supply and oscillator units. Besides simplifying service and maintenance, this permits on-the-job model conversion. In its higher-powered type—designated Model 253—the generator has an input power of 4000 d-c watts, which provides for average weld lengths of 20 inches. Variations in specific conditions permit variations in this capacity up to a maximum of 60 inches on 0.020 vinyl. Operating at an output frequency of 27 megacycles, the Model 253 weighs 113 pounds. Fitted out with the lower-powered sub-assemblies, the unit is designated as the Model 153, with an input power of 2000 d-c watts, alternative output frequencies of 27 or 41 megacycles, and a net weight of 94 pounds. This type is rated for average weld lengths of 20 inches, although maximum weld lengths of 36 inches on 0.020 vinyl have been performed.

◆ ◆ ◆

A water-resistant, high-strength sealing tape for cartons, paper tube ends, and bundles has been introduced by the Permacel Tape Corp., New Brunswick, N. J. Paper-backed and specially impregnated with a waterproof rubber resin composition, the new tape, known as P17, is designed to withstand extremely rough handling in shipment under both dry and wet conditions. Greater protection is given to contained merchandise because the tape will not split or tear at package closure points. The rubber type pressure-sensitive adhesive assures quick-stick and extra tight sealing. Unlike gummed tape, self-sticking P17 requires no activating solvent, permitting faster and cleaner application. The extra operation of moistening tape is eliminated, as well as the danger of the solvent's damaging the contents of the package.

◆ ◆ ◆

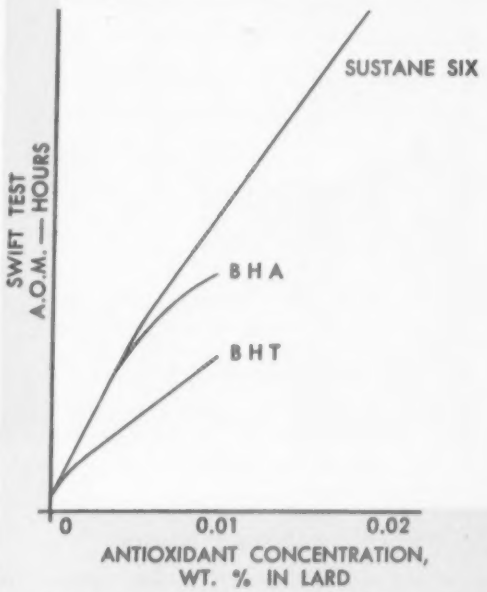
Corrosion and scale formation are reportedly eliminated and prevented in boilers and water systems by a **revolutionary new water conditioner** marketed by Packard Manufacturing Co., 2220 W. Beaver St., Jacksonville 9, Fla. The firm states the conditioner represents the first important commercial application of nuclear physics principles to the effective treatment of an industrial problem since it prevents scale and corrosion by imparting added energy to the atoms of the water solution. The unit, manufactured in sizes handling from 6.5 to 1760 gallons per minute, has no moving parts and requires no expensive maintenance or servicing either in the form of labor or added chemicals. The units are guaranteed for a period of ten years.

◆ ◆ ◆

A 14-month old mechanized materials handling program at Waxide Paper Company's St. Louis plant has reduced wax handling time 80%, and eliminated hot-weather difficulties. This

GET
BONUS PROTECTION
AGAINST RANCIDITY
WITH

Sustane Six



It's simple when you stabilize with Sustane Six for you get the protection of two potent antioxidants *plus* the synergistic effect of a BHA and BHT combination.

The curves tell the story. They compare the stabilizing effect of Sustane Six, butylated hydroxyanisole, and butylated hydroxytoluene in a lard of relatively low stability. Note how Sustane Six adds so much to the stability above that supplied by BHT. It's a proved fact that far greater A.O.M. stability is possible in lard with Sustane Six than can be obtained with either BHT or BHA used alone in the approved concentrations.

And that's not all. Sustane Six has the added advantage of being readily soluble in fats and oils. It is low in cost per pound of protected product. It presents no problem of product discoloration. And it offers greatly improved carry-through properties.

Sustane Six has been fully approved for use in fats and oils. So . . . your next logical step is to try it in your product.

Want more details? Write us.

PRODUCTS DEPT.
UNIVERSAL OIL PRODUCTS COMPANY
UOP
30 ALGONQUIN ROAD,
DES PLAINES, ILL., U. S. A.

Preserve the "fresh" flavor of

Citrus and other Essential Oils

with **Tenox** EASTMAN FOOD-GRADE ANTIOXIDANTS

For complete information about the effectiveness of Tenox in combating oxidative deterioration in citrus and other essential oils, write to

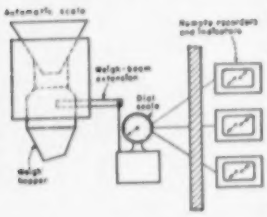
EASTMAN CHEMICAL PRODUCTS, INC.
Subsidiary of Eastman Kodak Company
KINGSPORT, TENNESSEE

FOOD INDUSTRY TOPICS

has been accomplished by palletizing the wax and using two electric industrial trucks manufactured by the Automatic Transportation Co., 149 W. 87th St., Chicago, to move, stack, and store the loads. Prior to palletization, it took four men five hours to unload one boxcar load. Since palletization, Waxide has found that two men, working with the Automatic trucks, can in little more than an hour empty, move, and store a complete carload of bulk wax.

◆ ◆ ◆

Richardson Scale Co., Clifton, N. J., announces development of **remote indicators and recorders that have standard accuracies of one part in 2000.** Higher accuracies are available, if desired. Designed originally for weight control, the remote units precisely follow a prime-mover dial scale. In operation, the weight of material fed to the automatic scale's weigh hopper is indicated on the dial scale. These readings are synchronized and duplicated on an indicator in any chosen remote location. Remote recordings may be made either on circular charts, strip units, or tape printers. Remote indicating and recording units may be hooked up to any industrial-make scale dial, and any number of units may be run by the one prime-mover. Heart of the instrumentation is a 60-cycle servo system developed by Richardson. It consists of a synchro transmitter, amplifier, and a servo mechanism made up of a servo motor and control transformer.



An inexpensive filler for Polyethylene "plastic squeeze bottles" has been announced by F. L. Burt Co., 571—7th St., San Francisco, Calif., manufacturer of Simplex Fillers. Designed especially for Rolley's, Inc., in the filling of suntan lotion, the filler is now available in either the manual or fully automatic model for filling polyethylene containers with any liquid or semi-solid. The manual model fills from 15 to 30 containers per minute; the fully automatic model with conveyor fills 40 to 60. The automatic filler handles 2, 4, or 8 ounce glass jars as well as plastic bottles. The fillers come equipped with cone or "U" shaped hoppers, or the intake can have a direct flow-line connection.

. . . *the literary corner*

"A summary of Methods and a Suggested List of Equipment for the Determination of Moisture in Food, Food Products, Insecticides, and Fungicides according to the Official Methods of the Association of Official Agricultural Chemists, Seventh Edition, 1950," is available from Central Scientific Company, 1700 Irving Park Rd., Chicago 13, Ill., manufacturers of Cenco scientific instruments and laboratory supplies. Ask for pamphlet FM-2.

◆ ◆ ◆

A beautifully done, 48-page brochure, **"Sugar in Bread Baking,"** by Raymond T. Bohn of Bohn Food Research, Inc., Scarsdale, N. Y., has been received from Sugar Information, Inc., 52 Wall St., New York City. Its major sections include Sugar Usage in Bread (including fermentation, fermentation tolerance, crust color, sweetness and flavor, softness, and baking time and yield); Sugar and Dough Properties; Sugar in Pre-Ferments; Sugar and Sweet Dough Preparations; Costs and Values; Handy Facts for Bread Makers; Sugar in Bulk; Sugar Storage; Sugar Facts; and Bread Standards. Author Bohn, an IFT member, has for the past 30 years directed the laboratory activities of several of the country's largest baking companies, and presently heads a consulting firm specializing in quality control in the baking industry.

◆ ◆ ◆

A bulletin on its new line of light conveyor belts for food handling or light industrial use has just been published by The B. F. Goodrich Company Industrial Products Div., Akron, O. Featured are the new Koroseal conveyor belts, in tan or white colors, for handling nuts, meats, greasy pans, cookies, bread, and other food products where temperatures range from 50° to 150° F. For light industrial use, the new Koroseal belts are recommended wherever resistance to oils, mild acids, alkaline, or neutral salts is important. Also introduced are the firm's new "Highseal" and "Kleenseal" rubber conveyor belts made in a scientifically tested "eyerest" green which is said to increase inspection efficiency by reducing glare and eye strain.

◆ ◆ ◆

The June issue of *D&O News*, published by Dodge & Olcott, Inc., 180 Varick St., New York 14, N. Y., contains a new feature which will be a permanent part of the publication. Entitled **"Market Analysis Report,"** the section will discuss background and current market conditions for two or three important products each month. Since the special section is printed on both sides of a perforated column of the *News*, it is a simple matter to detach and keep on file.

◆ ◆ ◆

Complete specifications and description of a compact air filter, designed to prevent dirt, oil, water, and other foreign matter from entering pneumatic instruments, are contained in technical report TI 29-9-92a, published by the Foxboro Company, Foxboro, Mass. The unit described measures approximately 8½" by 4⅛", and can be mounted in a supported line or bolted to a wall or panel. Filter capacity is 4 cfm of air or natural gas; sump capacity is 12 cubic inches; filtering area, 21.2 square inches; and maximum working pressure, 150 psi.

(Continued on page 40)

For Vitamin A–Look to Merck

Large capacity of this new Merck Plant assures an uninterrupted supply of Vitamin A

Merck leadership in vitamin manufacturing assures quality Vitamin A for the food industry.

Merck offers Vitamin A Acetate in vegetable oil, a light-colored product, free from off tastes, eminently suited for use in margarine and other foods. Supplied in batch-size or bulk containers, 200,000 and 400,000 units per gram. For information on other potencies, write to the address below.

Merck's experience of almost two decades in the manufacture of vitamins is offered to help you in the application of Vitamin A to your processes..

Vitamin A, Merck

Research and Production for the Nation's Health

MERCK & CO., INC.
Manufacturing Chemists
RAHWAY, NEW JERSEY
In Canada: MERCK & CO. Limited – Montreal

sweet'en-er

That which sweetens or imparts a sugarlike flavor

Example: GLYCERINE!

In products like cough drops, toothpastes, candies, capsules, and medicines, where Glycerine's major properties make it an important ingredient, Glycerine's pleasant taste is an extra "plus." Glycerine not only acts as a humectant, demulcent, solvent, plasticizer or preservative in formulations of this type, but also enhances their flavor.

U.S.P. Glycerine is nontoxic and easily digested. Its applications in food processing have been accepted by the American Medical Association Council on Foods, and permitted by Federal and State food and drug authorities.

If you're developing a product that must have any of the properties mentioned—and be palatable too—check Glycerine.

New Pectin Jelly

For example, a concentrated pectin jelly composition was recently patented. When dissolved in hot water and then cooled, this solid aqueous gel forms a larger volume of edible jelly dessert. Glycerine acts as a sweetener.

Balance of Properties

Glycerine's sweetening action is only one part of the story. You can count on *versatile* Glycerine to serve as—

preservative	**bodying agent**
bacteriostatic	**stabilizer**
lubricant	**antifreeze**
penetrant	**blending agent**

Booklets on the application of Glycerine in the drug and cosmetic and food fields are available. For your copy, write Glycerine Producers' Association, 295 Madison Avenue, New York 17, N. Y.

Nothing takes the place of Glycerine

FOOD INDUSTRY TOPICS

(Continued from page 38)

A series of packaging machines handling single end closings of partial or full overlap cartons, telescope or center-slotted cartons of fiber or corrugated board is outlined in Bulletin PR/601, prepared by International Staple & Machine Co., Herrin, Ill. The booklet gives specifications and prices on the International Staple Princess series which includes models with one and with two stapling heads.

◆ ◆ ◆

An attractive, 20-page flavor catalog, well-illustrated with laboratory and factory photographs and with cover in full color, has just been issued by Fritzsche Brothers, Inc., 76 Ninth Ave., New York 11, N. Y. The new price list fully describes the applications of more than 30 separate groups of flavors embracing more than 700 different flavor types. Food and beverage manufacturers interested in the use of flavors may have a copy upon request.

The same firm also announces three additions to their fine flavor line; Oleoresin Black Pepper New, Oleoresin Sage Dalmatian, and Oleoresin Pimenta Berries. Working samples may be obtained by writing the company's Flavor Division at the above address.

◆ ◆ ◆

Applications of the Airveyor System in the pneumatic handling of flour are covered in a 16-page, two-color bulletin published by the Fuller Co., Catasauqua, Pa. Entitled **"Flow Your Flour,"** Bulletin AF-100 explains and illustrates how the Airveyor System pneumatically conveys flour from carriers to storage, and from storage to processing. Included is information on how the system eliminates bagging costs and cuts labor costs while providing sanitary, dust-free handling.

◆ ◆ ◆

A quick connect-disconnect hose coupling for water, oil, steam, gas, and chemical lines which provides permanent freedom from leakage is described in a bulletin offered by Titeflex, Inc., Hendee St., Springfield, Mass. Entitled **"Titeflex Quick-Seal Coupling,"** the 16-page booklet describes the simple construction of the coupling and points out how this construction provides (1) a unique sealing action which makes the coupling tighter as internal pressure increases, and (2) a full swiveling action that prevents hose twisting and kinking. Also described are single and double-check valve modifications of this coupling which permit disconnecting lines without shutting down pumps, and which prevent escape of valuable or hazardous fluids when lines are opened.

◆ ◆ ◆

Performance characteristics and applications of the CP M.S. Crescent Plate Heat Exchanger, recently introduced by the Creamery Package Mfg. Co., 1243 W. Washington Blvd. Chicago, are now available to plant operators in Supplement No. 1, Bulletin E-1153. The CP M.S. Crescent is a compact, rugged plate heat exchanger with all mild steel surfaces, grit blasted, and coated with a gray plastic, corrosion-resistant paint. It is designed to be an extremely economical unit for use as a primary or secondary plate heat exchanger in small or large plants wherever stainless steel exterior finish is not required. The unit is suitable for cooling, heating, regeneration or H.T.S.T. pasteurizing of practically any free-flowing liquid.

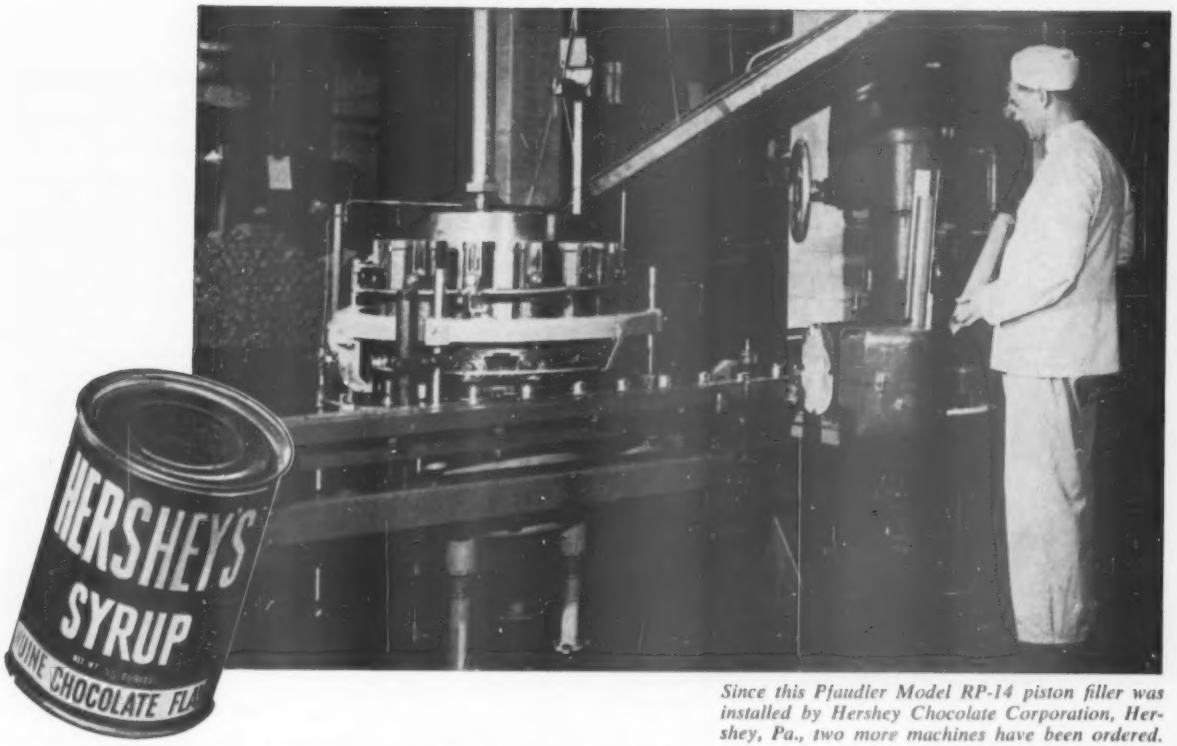
◆ ◆ ◆

Advantages inherent in the treatment of industrial waste waters and process liquors are described in Bulletin WC-116, **"Industrial Waste Treatment,"** just published by the Graver Water Conditioning Co., 216 W. 14th St., New York City. Schematic drawings, pictures, and a problem-solution-result type of explanation demonstrate how Graver equipment solves such problems as process and cooling water shortages, contamination of streams with plant effluents, and the loss of valuable heat and materials in discarded waters and process liquors.

◆ ◆ ◆

A 20-page booklet dealing with the construction and the entire operation of smokehouses has been prepared by Koch Sup-

(Continued on page 42)



Since this Pfaudler Model RP-14 piston filler was installed by Hershey Chocolate Corporation, Hershey, Pa., two more machines have been ordered.

Why Hershey Chocolate Corporation added more Pfaudler fillers to production line

Any product with the popularity of Hershey Chocolate syrup must be handled speedily to keep up with demand. There is no more sensitive spot on the production line than the filling operation. Failure here could really mean trouble.

Recently, Hershey installed a Pfaudler Model RP-14 piston filler with a capacity of 300 five-ounce cans per minute. Performance has been so smooth, so accurate that two more Pfaudler machines are being added to the line.

This experience parallels that of many other famous food companies – Gerber Food Products, Armour, Minute Maid, Beechnut Packing, A. & P., Birds Eye, and H. J. Heinz to name a few.

Control on these fillers is so precise that even at high speeds, filling is accurate to ±1/10 of an ounce on most products. Adjustments can be made while machine is operating. There is no slop-over or waste.

No dismantling tools required

Pfaudler fillers are extremely sanitary in design from top to bottom. For example, piston and valves can be disassembled without tools in a few minutes. No piston rings are used. Every part can be cleaned quickly and inspected visually.

Every Pfaudler filler is synchronized with the seamer to eliminate spillage and to prevent damage to containers at high speed.

These and other exclusive features have made Pfaudler piston fillers top choice with the top producers in the food industry. Don't you owe it to yourself to check the facts? The coupon is for your convenience.

Pfaudler

THE PFAUDLER CO., ROCHESTER 3, NEW YORK
Engineers and Fabricators of Food Processing Equipment

Gravity Fillers · Piston Fillers · Steam Peelers · Deaerators · Vacuum Pans · Evaporators

THE PFAUDLER CO., Dept. FT-8 Rochester 3, N. Y.

Please send me a copy of Bulletin 876, "Rotary Piston Fillers," right away.

Name .....

Title .....

Company .....

Address .....

City ..... Zone ..... State .....

SANITATION
starts with
IN-PLANT CHLORINATION

From start to finish of your processing operation, *Wallace & Tiernan In-Plant Chlorination* will keep your sanitation problems to a minimum by:

Eliminating slime formation on equipment and in work areas

Retarding bacteria growth

Greatly reducing offensive odors

For information on how In-Plant Chlorination can help solve *your* sanitation problems, write today to our Foods Division.

WALLACE & TIERNAN
INCORPORATED
25 MAIN STREET BELLEVILLE 9, N. J.

I-46

FOOD INDUSTRY TOPICS

(Continued from page 40)

plies, 2520 Holmes St., Kansas City 8, Mo. This informative booklet, entitled **"Successful Meat Smoking,"** is also crammed full of facts about smoking a wide variety of foods, including ham, bacon, sausage, and fish. For a free copy, write to Dept. 26 at the above address.

◆ ◆ ◆

"Becco Bulletins and How They Grew," is a feature story in the June issue of *Becco Echo*, published by Buffalo Sales Corp., sales agent for Buffalo Electro-Chemical Co., Inc., Buffalo 7, N. Y. Says the *Echo:* "Once upon a time there was a little bulletin listing the few peroxygen compounds we made. Today there is a list of 60 bulletins; next year there will be nearly 70. The number grows, not because we come out with half a dozen new products each year, but because our products find new uses we want to tell you about. . . . Thousands (of the bulletins) are mailed annually on request, and the number is growing. These large mailings indicate that readers like these bulletins, that they are of interest to you, and serve a purpose. We shall continue to produce and make available new and interesting bulletins on peroxygen chemicals and their uses." A postcard included with the *Echo* permits the reader to send in for any of the bulletins listed, in any desired quantity.

◆ ◆ ◆

In connection with the 25th Anniversary Celebration of the frozen foods industry, General Foods Corporation has published a 43-page mimeographed research report which tells the history of the industry's pioneering company and shows the impact of the frozen-foods industry on other industries since June 6, 1929, when the Postum Company—later renamed General Foods—acquired the rights to the quick-freezing process and thus started the industry which has profoundly affected American living.

. . . *building up and branching out*

The world's largest laboratory devoted to research and development of asbestos brake linings and other friction materials was opened at Manville, N. J., on June 15, as Johns-Manville's answer to increasing demand for better control and safer stopping of all types of mechanical equipment. At the same time, Mr. A. J. Bette, manager of the Johns-Manville Friction Materials Dept., announced an addition to the firm's plant at Waukegan, Ill., which will nearly double the passenger car and industrial friction material production capacity there and create about 350 new jobs when the new facilities are completed in 1955. The Waukegan addition is part of the $18,500,000 Johns-Manville plans to spend for expansion and improvement in 1954, according to Mr. Bette.

◆ ◆ ◆

To meet the growing demands of industry, the Pennsylvania Salt Mfg. Co., 1000 Widener Bldg., Philadelphia 7, has more than doubled its capacity for the production of anhydrous ferric chloride, Pennsalt's Industrial Chemicals Division has announced. A new plant as part of the Wyandotte, Michigan Works is the reason. Anhydrous ferric chloride is widely used in sewage and water treatment, serves as a catalyst in the manufacture of certain organic chlorides, as an etchant in photoengraving, and is used in Friedelcrafts reactions and the recovery of glycerine.

◆ ◆ ◆

Concrete evidence of **aluminum foil becoming more desirable for packaging food** is Pacific Coast Foil Company's new, ultramodern $1,000,000 foil converting and foil printing plant located at 177 So. Airport Blvd., South San Francisco, Calif. The

Trutaste flavors!

The Economy Line

HIGH CONCENTRATION ···LOW COST PER BATCH

NEUMANN, BUSLEE & WOLFE, INC.
5800 NORTHWEST HIGHWAY CHICAGO 31, ILL.

company, a division of Jorgenson & Co., San Francisco printers and lithographers, is one of the larger producers of printed foil packaging and labeling materials in the country. According to Mr. Ralph J. Jorgenson, president of the parent firm, the customer appeal, beauty, and product protection advantages of foil labels and wrappers have caused food processors and distributors to change to this form of flexible packaging after the process of gravure printing on foil had been perfected. "The market for foil for packaging, labeling, and other uses is just beginning," said Jorgenson, "and, although the South San Francisco plant provides three times more working area than our former quarters, the company owns four-and-one-half acres surrounding the new building which will be expanded again when necessary."

. . . *the human element*

The promotion of **Mr. John M. Sarther** to the position of director of distribution of Consolidated Foods Corporation for the Chicago and Midwest area has been announced by Mr. S. M. Kennedy, president. Mr. Sarther, formerly president of the corporation's Sprague Warner division, is also a vice president and director of the parent company. **Mr. Arthur G. Ender,** formerly vice president in charge of sales at Sprague Warner, has been named president of the Sprague Warner division to succeed Mr. Sarther.

Mr. Ender

◆ ◆ ◆

Barbara Hutchings Evers, nationally known home economist and co-author with Donald K. Tressler and C. F. Evers of the

Advertisers' Index

	Page
Abbott Laboratories	9
Aseptic Thermo Indicator Company	43
Assn. of American Soap & Glycerine Producers Inc.	40
Diamond Crystal Salt Company	28
Distillation Products Industries	6 and 7
Dodge & Olcott, Inc.	13
Eastman Chemical Products, Inc.	38
Florasynth Laboratories, Inc.	29
Food Development Laboratory	44
Food Machinery & Chemical Corp.	31
Food Research Laboratories Inc.	44
Fritzsche Brothers, Inc.	25
Givaudan Flavors Inc.	34
Griffith Laboratories Inc.	19
Hoffmann-La Roche Inc.	4
International Minerals & Chemical Corp.	27
Klenzade Products Inc.	32
H. Kohnstamm & Company Inc.	1
LaWall & Harrisson	44
Magnus, Mabee & Reynard, Inc.	24
Merck & Company, Inc.	39
Minneapolis-Honeywell Regulator Co.	14 and 15
Monsanto Chemical Company	17
Neumann-Buslee & Wolfe, Inc.	42
Norda Essential Oil & Chemical	4th Cover
The Pfaudler Company	41
Chas. Pfizer & Company, Inc.	2nd Cover
Polak's Frutal Works	30
Rohm & Haas Company	5
Schwarz Laboratories, Inc.	44
Seaplant Chemical Corp.	36
Sheffield Chemical Company	21
A. E. Staley Mfg. Co.	3
Wm. J. Stange Company	11
Sterwin Chemicals Inc.	33
Sugar Information, Inc.	22 and 23
Universal Oil Products Co.	37
U. S. Stoneware Company	35
van Ameringen-Haebler, Inc.	3rd Cover
Wallace & Tiernan, Inc.	42
Wisconsin Alumni Research Foundation	44

Is a link missing in your Quality Control Chain?

But he can *be prepared* in advance to spot the trouble *the moment it occurs* by using

cook chex

No Food Technologist can tell *in advance* when a batch is going to "go bad."

...MPERATURE SPECIFICATIONS FOR FREE COOK-...ATORS CUSTOM-MADE TO FIT YOUR REQUIREMENTS

COOK-CHEX
11471 Vanowen St. North Hollywood, Calif. FT-34

Without obligation, please send me a supply of COOK-CHEX indicator tags designed for use at _____ degrees F., for _____ minutes.

Name _____

Position _____ Company _____

Address _____

City _____ State _____

FOOD INDUSTRY TOPICS

book, *Into the Freezer and Out*, has joined the staff of the Division of Home Economics of the American Meat Institute Foundation, Chicago, it was announced by Dr. H. R. Kraybill, the Foundation's director of research and education. Mrs. Evers received her B.S. and M.S. degrees in foods and nutrition from Drexel Institute of Technology, Philadelphia. She has directed research on the cooking of frozen foods and the freezing of cooked foods for Birdseye-Snider, Inc., the National Association of Frozen Food Packers, and John H. Dulany and Sons.

◆ ◆ ◆

Mr. Robert S. Bloomer, Sr., has been named president and director of sales of Bloomer Bros. Company, Newark, N. Y., manufacturers of paperboard and folding paper box specialties. He succeeds the late George L. Richmond, who died March 29, 1954. Mr. Bloomer is the son of R. A. S. Bloomer, one of the company founders, and has been associated with the firm for 32 years. At the same time, directors of Bloomer Bros. Company elected Mr. Harrison C. Bloomer as vice president and general manager, in which capacity he will have charge of production. **Mr. Wilson C. Bloomer**, as vice president, was given additional responsibilities in the fields of maintenance and engineering.

33 years ago they told me:

"YOU HAVE LESS THAN A YEAR TO LIVE!"

"MUST HAVE BEEN back in 1919 or '20. Hopeless case of diabetes. No known cure.

"BUT HERE I AM. They found a treatment—insulin—in time. Today, *nobody* has to die of diabetes.

"CANCER, I know, is a tougher problem. But the laboratories can lick that one, too—with our support. Already, they're curing people who would have been done for a few years ago. Last year—thanks to $5,000,000 allocated by the American Cancer Society from our contributions—they found out a lot more . . . though there's still a long way to go.

"THEY NEED MONEY, though. $5,000,000 is still less than 4 cents per American *per year*. Not enough to find the answer *fast* enough—230,000 Americans are going to die of cancer *this year*, they say.

"I'M NOT RICH, but I gave 'em $50 last year—hope to do better this time. After all, where would *I* be if the laboratories working on diabetes, that time, hadn't been given enough support—?"

Cancer
MAN'S CRUELEST ENEMY
Strike back—*Give*
AMERICAN CANCER SOCIETY

EMPLOYMENT NOTICES

WANTED: Food Technologist. Recent graduate or with 2-3 yrs. experience. Nationally known food company located in Western New York. Work in quality control at start, with possible openings in plant operations. Write fully, giving complete details. REPLY BOX 340, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

AVAILABLE: Food Technologist, 25 yrs. versatile experience in research and development of food products, specializing in baked foods. Desires connection with food processor, bakery, restaurant or allied supplier of ingredients or services where broad background and experience may be employed for formulae development, processes and/or quality control. Chicago headquarters. Wide range of experience in U. S. A. European background. REPLY BOX 338, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

WANTED: Food Specialty Salesman. A real opportunity in Chicago for a man with food processing experience who can do a professional selling job. Substantial salary plus expenses and company car plus liberal commission to man who qualifies. Company in business over fifty years manufacturing nationally known specialty products for the food industry. All replies confidential. REPLY BOX 337, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

WANTED: Bakers yeast specialist familiar with all phases of production. Location Far West. Send summary of education, experience and salary requirements. REPLY BOX 336, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

AVAILABLE: Food Chemist. Desires permanent academic position for teaching and/or research. B.S., M.S. (Chemistry), Ph.D. (Food Technology). Two years postdoctoral research and teaching experience in oil and fat chemistry and technology. A number of publications. REPLY BOX 339, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

Prominent manufacturer of agricultural products has opening for chemist with experience in organic analysis, biochemistry and formulation work. Must be able to supervise analytical and product formulation laboratories and do some technical writing. Midwest location, salary commensurate with experience and ability. Reply giving full details. BOX 341, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

WANTED: Baking Technologist, with cereal chemistry background, qualified to develop new bakery products, set up control standards for production and purchasing, analyze materials. Chicago location. Write full particulars. Replies confidential. REPLY BOX 342, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

Food Ingredient & New Drug Studies
ANIMAL TESTS
LaWall & Harrisson
Bacteriologists
Chemists
Pharmacologists

Food Development Laboratory
S. W. ARENSON, DIRECTOR
Proof service to the baking and potato chip industries. Ingredient evaluations. New product development. Baking, frying, spray drying equipment. Chemical and physical testing facilities.
2865 W. Franklin St. Baltimore 23, Md.
440 W. 24th Street New York, N. Y.

FOOD RESEARCH LABORATORIES, INC.
Founded 1922
Philip B. Hawk, Ph.D., President
Bernard L. Oser, Ph.D., Director
Research • Analyses • Consultation
SODIUM DETERMINATIONS
Biological, Nutritional, Toxicological Studies for the Food, Drug and Allied Industries
48-14 33rd Street, Long Island City 1, N. Y.

WISCONSIN ALUMNI RESEARCH FOUNDATION
PRODUCTION CONTROL SERVICES
Vitamin D rat assay – results in 8 to 10 days • U.S.P. XIV or A.O.A.C. vitamin A assays • Other vitamin assays • Antibiotic and amino acid assays • Sodium Determinations • Proximate analyses and mineral determinations. Pharmacology including warm-blooded toxicity studies • Specific immune sera • Enzyme investigations • Other biological, chemical, and microbiological services.
Project Research and Consultation
WISCONSIN ALUMNI RESEARCH FOUNDATION
P.O. Box 2059-S • Madison 1, Wis.

Schwarz
SERVICES TO THE FOOD INDUSTRIES
• Consultation on Food Problems.
• Analyses of food materials and products.
• Food plant design, process examination and control.
• Legal testimony and consultation on government regulations.
Founded 1867
Write for bulletin "Scientific Quality Control of Foods and Beverages"
SCHWARZ LABORATORIES, Inc.
230 Washington St., Mount Vernon, N. Y.

Sealva*

THE NEW HERMETICALLY SEALED **FLAVORS**

Success

The unusual success of the remarkable SEALVA* process is attested to by its wide acceptance in almost every branch of the food field. Already SEALVA flavors are being used in commercial production in—

- Pie Fillings
- Cake Mixes
- Cake Icing Mixes
- Pudding Powders
- Gelatin Desserts
- Ice Cream & Sherbet Mixes
- Confectionery Cream Centers
- Pressed Wafers
- Chewing Gum
- Pharmaceuticals
- Summer Drink Powders

SEALVA flavors can undoubtedly improve the taste and acceptance of your product. Samples and technical data at your request.

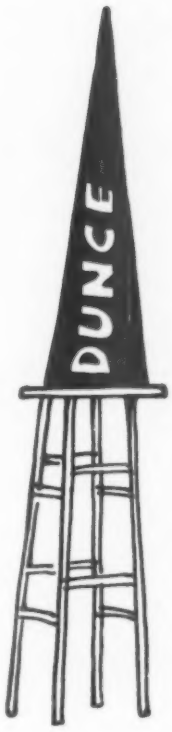
VAN AMERINGEN-HAEBLER, INC.

521 WEST 57th STREET • NEW YORK 19, N. Y.

Alva FLAVORS

* The SEALVA process is a method whereby minute droplets of flavor oils are sealed against the ravages of atmosphere and shelf-life within an impermeable membrane of edible gum. The flavor contained in this dry powdered form is released instantly in the mouth or in liquids.

When Nature Hasn't Played Fair with a Grape



You sometimes have to give Nature a boost, for the sake of your own pocketbook. That's when Norda can be a big help.

Here's how it works:

You use Norda genuine natural fruit Flavors, because they give your products real true-fruit taste. They're rich and wonderful.

Maybe, though, it's not profitable to use *all* natural fruit flavors. Then "piece them out" and supplement them with Norda imitation Flavors. They have the same fine characteristics. They're full-bodied, true to type, almost indistinguishable from the genuine. You can economize with them, without skimping on strength or quality.

Norda Grape Flavor will show you. Let us send you *free* samples of both genuine and imitation. Send your request today.

–Come to Norda

Use a Norda "Favorite to Flavor It" Norda

Norda, Inc., 601 West 26th Street, New York 1, N. Y.

Chicago • Los Angeles • San Francisco • Montreal • Toronto • Havana • London • Paris • Grasse • Mexico City